ROADS and STREETS

Issued Monthly at Hammond, Ind.,
by Engineering and Contracting Publishing Co.

Executive and Editorial Offices:
221 East 20th St., Chicago, Ill.
Address all communications to the above office.

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Subscription Price $2.00
Foreign Postage 65c Extra

Vol. LXVII APRIL, 1927 No. 4

Some Editorial Lectures on Public Extravagance

The most reliable estimate of the annual income of the American people puts it at 90 billion dollars. Barely one per cent of this total, or one billion, is spent on road construction and maintenance, yet not a few editors of daily papers are advocating a general reduction in taxation, including taxation for highways.

All taxes, local and federal, consume about 10 per cent of the income of the American people, and it is noteworthy that as fast as the federal taxes have declined the local taxes have increased. From this it is argued that local taxes are extravagantly high; but this inference can not be properly drawn from these facts. Indeed, when proper allowance is made for our increase in population and for our per capita increase in productivity, our local taxes are not out of line with what they were 10 years ago. There was no general exhortation to reduce local taxes at that time. Why, then, has it become the editorial fashion to urge local tax reduction now? The answer appears to be that the spectacular reduction in federal taxes has led many editors to reason that a similar reduction in local taxes should have been effected.

Federal taxes reached large proportions as a result of the war, and long after the war ended they remained very high, partly because it was not an easy matter to get rid of federal employees, partly because we were loaning money to Europe for rehabilitation purposes, and partly because the nation had gone into several losing lines of business, notably the operation of a merchant marine. But under a vigorously applied policy of retrenchment, the President was able to bring the federal government back to a peace time footing. Coincidently the rising income of the American people made it possible to reduce the national debt rapidly, in spite of progressive reductions in income tax rates.

On the other hand, local taxes, instead of being swelled by the war, had been curtailed by it. The building of schoolhouses, roads, etc., had actually not kept pace with the growing needs of the people. Hence, it was but natural that local taxes should rise after the war, just as it was natural that federal taxes should decline.

Wages and salaries have doubled in 10 years, and construction costs have also doubled. But the editors who are urging local tax reductions seldom refer to this important change in the price level. They are prone to talk in dollars only, without equating for the reduced purchasing power of the dollar.

They often speak of extravagant taxation for road purposes, but they seldom refer to the vastly greater expenditure for automobiles as being extravagant. After all, what constitutes extravagance? Apparently an editor's conception of an extravagant person is one who spends his income in a manner that does not meet the editor's approval.

Our taxes may still be the old prewar 10 per cent of our income, our savings banks may still contain the prewar percentage of our wealth, our annual investments in stocks and bonds may greatly exceed the prewar percentage of our income, our percentage of home owning individuals may be steadily rising. All this counts for naught when a verbally extravagant editor decides to lecture his readers on economy as applied to public necessities.

H. P. Gillette

Another Billion Dollar Year

For several years expenditures in the highway field have ran well over a billion dollars each year. That the present year will see no falling off in the road building and maintenance programs is shown by estimates given out last month by the U. S. Bureau of Public Roads. Reports obtained by the bureau from state highway departments indicate a proposed total expenditure of $1,123,000,000 in 47 states. Connecticut is not included at this time owing to the uncertainty of pending legislation. Of the above total $648,483,000 will be expended under the supervision of state highway departments, and $475,000,000 by counties and other lesser subdivisions. Of the expenditures by state highway departments it is estimated that approximately $421,000,000 will go for new road construction, $56,000,000 for new bridges, $27,000,000 for reconstruction and $126,000,000 for maintenance. The state highway programs call for the construction of 7,489 miles of asphalt, brick or concrete roads, 12,395 miles of sand-clay, gravel or macadam roads, and 6,957 miles of improved earth roads.

Aggregates Cause Spalling

To the Editor: We have had several cases come to our attention last fall, one on our own work and three others, where one course concrete slabs have spalled to a small extent. One case which could be observed easily and of which we knew the exact conditions is cited below.

During the early part of December we repaired a driveway that had been broken out to make a connection with the sewer drain, there being about 75 sq. ft. of the repair, laid in one course, 5 in. thick. The concrete stood for about 3½ days with moderate temperature, then it turned cold, freezing quite hard. Six spots about 1½ in. to 2 in. in diameter raised slightly above the original surface. Directly underneath each one and from ⅜ to ½ in. below the surface was a pebble or stone approximately ⅝ in. in diameter.

These six stones, under the chipped places, were carefully removed and a few simple tests made. Two of the pebbles were placed approximately ⅜ in. below the surface in a block of concrete about 12 in. square and 6 in. thick; two were embedded in another block of the same general dimensions about 1½ in. below the surface; and the remaining two were placed in a block of concrete ⅜ in. under the surface, as in the first case.

The first and second blocks were cured for 60 hours at a temperature of about 60 degrees and were then placed outdoors, the temperature that night being 10 degrees above zero. The block with the two stones ⅜ in. below the surface chipped above the stones in the same manner as the concrete did above the same pebbles in the driveway. The second block did not chip above the stones; however, at one corner a place chipped and a stone, which was in the gravel used to make the block, was directly underneath. The third block was cured for 108 hours at a temperature of about 90 degrees, then placed out of doors in a temperature of about 8 degrees above zero. The block remained outside for four days, the temperatures each night being well below freezing. On inspection the surface was found to be in perfect condition as all three were, with the exception of the two raised spots on the first block

The above cases seem to lead to the conclusion that the pebbles were more porous than the average and that the concrete was subjected to freezing temperatures before the moisture contained in the pores of the pebble had evaporated or before the concrete had sufficient strength to overcome the pressure exerted by the freezing of the moisture. Also that when pebbles of this nature were of a sufficient depth below the surface, the concrete had strength enough to withstand the pressure caused by freezing.

After the tests were made the stones were removed and found to be as hard as the average gravel obtained in this section and upon fracture they in no way resembled rotten stone.

We would appreciate, very much, some further information on this subject if there is any available and also an opinion expressed as to the correctness of the above conclusions.

Canton, Ill. R. W. VAN HOUTEN.

[Can any reader contribute facts or ideas that will explain this case? Mr. Houten's theory of the cause for the trouble is interesting, and his test practical. Whether or not both are correct will be left to the reader to judge. At least this opens up a fruitful field for open discussion.—The Editor.]

Reducing Over-Run of Cement in Concrete Paving

To the Editor: In your issue of March, 1927, I noticed an editorial comment on the over-run of cement in concrete in paving construction. In this connection, I offer the following comments:

The usual reasons for over-run are low subgrade, inexact specification of proportions, inattention to grading of materials and bulking, due to moisture, careless setting of headers, improper operation of tamping and finishing machines and other careless workmanship.

The corrections which are applied in this state apply to the conditions which we think are out of the control of a contractor doing ordinary good work. For instance, we recognize the fact that it is impossible to make a perfectly uniform subgrade, and it is our custom to allow the contractor the cost of the cement for extra thickness up to ½ in. Since the cross-section is measured at 25-ft. intervals, it is quite easy to determine whether careless work is being done or not. We insist upon a carefully graded mix of aggregates with accurate corrections for moisture. Since the state controls the proportions of the admixtures and has taken this matter out of the hands of the contractor, it is our custom to pay for over-runs of cement due to errors made by our inspector in proportioning. Due to these methods, our over-runs of cement in concrete have been reduced to less than 2 per cent on any day's run, and on a contract of any size, the total over-run is negligible, since the amount overrunning one day is quite often underrun the next day and the proper thickness of pavement is still maintained at all times.

Our method of proportioning cement is different from that in use in many locations, in that we specify the number of sacks of cement in each cubic yard of concrete in place which takes away from the contractor any worries with regard to yield of concrete per barrel or sack of cement. By keeping the cement constant, we have mixes varying from 1 part cement to 1.65 parts fine agregate, and 3.8 parts coarse aggregate to mixes running 1 part cement to 1.98 parts fine aggregate and 3.4 parts coarse aggregate.

Both of the above mixtures give us 1 cu. yd. of concrete per 6 sacks of cement but the percentage of voids in the different aggregates and the shape of the aggregate is such that variations in proportions are necessary.

We have found these methods very successful, in that they are satisfactory to the contractor; also the state secures a corresponding advantage in low unit prices which makes it well worth our while to take care of the contractor on all those portions of the construction in which the limitations of present construction equipment makes error unavoidable.

Sacramento, Calif.

C. S. POPE,
Construction Engineer.
California State
Highway Commission.

National Conference on Asphalt Paving Announced

The Sixth Annual Asphalt Paving Conference is announced to be held at the Atlanta-Biltmore Hotel, Atlanta, Georgia, during the week of Nov. 28, 1927. The conference is held under the auspices of The Asphalt Association, of which J. S. Helm of the Standard Oil Co. of New Jersey, New York City, is president.

The Association of Asphalt Paving Technologists, of which Hugh W. Skidmore of the Chicago Paving Laboratory, Chicago, is president, will cooperate with The Asphalt Association in the holding of a joint conference.

The Fifth Annual Asphalt Paving Conference was held at Washington in November, 1926, and brought together more than 600 state, county and city engineers, paving contractors, asphalt producers, consulting engineers and others identified with asphalt paving.

Annual Meeting of Florida Engineering Society

The eleventh annual meeting of the Florida Engineering Society was held in Clermont, Florida, on March 21 and 22. Committee reports, discussions of prospective legislation and technical papers comprised the events of the program. Papers treating of "City Planning in Florida" by Chas. Wellford Leavitt; "Engineering Conciousness" by H. D. Mendenhall; "Pressures Back of Seawalls" by C. H. Ruggles, and "The Control of the Kissimmee River" by C. C. Browne were delivered and discussed. The newly elected officers for the year 1927-28 are: George W. Simons, Jr., Jacksonville, President; C. A. Brown of Orlando and J. E. Craig of Jacksonville, Vice-Presidents; J. R. Benton, Gainesville, Secretary; G. A. Main of Daytona Beach, Treasurer.

Surface Treatment of Gravel and Stone Roads

Experiences in Constructing Tar Mat on 12.6 Miles of Old Road Described in Paper Presented Jan. 21 at 13th Annual Road School, Purdue University

By C. C. NEWSOM
District Engineer, Indiana State Highway Commission

Prior to the year 1926, a few small sections of state road had been surface treated with tar and were known as surface treated gravel and stone roads. So far as I know, this method has proven very successful. It has relieved the traveling public of the dreaded dust nuisance during the summer or hot dry months.

About the first of the year 1926, it was decided to surface treat about 12.6 miles of what we thought would be a gravel road. Suffice to say, that we had been maintaining this section or rather two sections of road as a gravel road. This road which we proposed to surface treat lies between Lebanon and Frankfort and is now known as State Road No. 39.

This particular road will be described, not because it is an ideal piece of work but because a description of it with all the errors and defects together with the commendable features might be helpful to those who are contemplating similar work.

Long Base Drag Used to Eliminate Wavy Surfaces Preparatory to Surface Treatment

Our old roadbed averaged about 20 to 22 ft. in width which was hardly enough to permit us to have a treated surface of 20 ft. and have sufficient shoulder to hold the metal base. We succeeded, however, in obtaining, in most places the additional width of right of way that we needed, which permitted us to go forward with our shoulder work in a satisfactory manner.

Preparation of Base.—About Feb. 15, 1926, we began to look forward to getting our gravel base in condition to receive the tar in the spring of the year. We began to patch the places which we expected to be weak and at the same time eliminate the many waves which had been in the surface for some time. Before we had progressed very far along this line, we began to have our spring thaw, after which, we found ourselves up against a real job and were facing 12 miles of road, 50 per cent of which, had broken up or in other words failed. Although we had been reasonably sure that it was at least 8 to 10 in. This was true in some places and I will say, that where that condition existed, we had very little trouble. But in many places, the depth of the old metal ran as low as 4 in. and of course here we had trouble when the frost began to come out of the ground.

Owing to the soft condition of the road, it was necessary that we resurface its entire length in order to get sufficient base to withstand the heavy traffic and make it suitable for the proposed tar treatment. This we did with stone as a base course, using mostly our 2½ in. to 1½ in. size crushed limestone. We did not conform to any standard depth for the stone, that depending on the condition of the particular stretch of road on which it was placed. I have in mind some places which will be mentioned later, where we placed as much as 12 to 15 in. of stone and still had a spongy condition.

Preparing Shoulders Preparatory to Surface Treatment

Applying Stone for Base Course.—This stone was placed on the road with our own trucks and was distributed as evenly as possible, taking in consideration, that we needed it heavier in some places than in others on account of the wavy condition of the surface. Rather than do any extensive scarifying or cutting off the high places, we deemed it better to bring up the low spots. The only scarifying that we did was done in some places where the old surface of the road had become caked and hard. In these places, in order that the large stone might have a tendency to embed itself, we used the scarifier to a depth of about 1 in. or just enough to give us a small amount of loose material to hold the stone. After this heavy stone had been placed on the surface, it was smoothed down with a drag or a combination tractor and grader

Scraping Treated Material to Center of Road, Preparatory to Applying Second Coat of Material

outfit, after which it was rolled with a 10-ton roller, continuously. Here, I might say, that we found it better to confine the rolling to short stretches of road, rather than to go long distances before turning. In other words, it is more satisfactory and more economical to complete the short stretch rolling as you go, where the rolling of the coarse stone is concerned.

After the surface had been rolled the first time, some waves or low places were noticeable. These places were filled with a few wheelbarrow loads of large stone and then rerolled. It is true that the traffic, which we did not stop, loosened up the stone after it had been rolled, but we found that a considerable good was done with the roller and that by rolling continuously, we found that, after each rolling, a less amount of the stone was loosened up by the traffic. Our drags also loosened up some of the large stone. Of course it was necessary that we keep the surface smooth with a drag or a grader and that emphasizes the fact that continuous rolling should be carried on.

Inasmuch as we were only going to treat about 20 ft., we confined the metal to that width by setting line stakes and throwing a berm up against the stone along the 20-ft. line. These berms will get mutilated somewhat by the traffic turning out onto the shoulders, but should be repaired and kept lined up.

In applying the heavy stone, it was our aim to get as much as possible of it on the road as early as possible while the surface was wet and soft. For that reason, we did not attempt to apply any binder material until all the heavy material was on the road. Furthermore we wanted the heavy stone to be packed so far as possible, before applying the finer aggregate. Our aim was to get a hard, but somewhat porous surface and at the same time, have as smooth a riding surface as possible. A hard compacted slick surface will not take tar and where such surfaces existed, even though the road seemed to be in a fine condition, it was necessary to apply some 1½ in. stone to get the roughened porous surface that was desired. Also, I might say here that stone with dust cannot be used.

Trouble with Clay Subgrade.—As I mentioned before, we had some soft seepy places that did not heal up until the first part of the month of May. Underneath the metal, what little there was, there seemed to be a layer of soft plastic clay material, ranging from 8 to 16 in. deep. Underneath this clay was hardpan which held the water and prevented the top layer from drying. We kept adding large stone to these places, but without much success and finally resorted to the pick and shovel. We had this clay dug out and thrown to the side of the road and filled the depression with dry stone. I believe a small drain title leading from the ditch, through the shoulder, to about the edge of the metal will help this condition.

Graveling Over Stone Base.—After we had finished spreading the large stone, we began to place some gravel over the surface, beginning where it was necessary to place the large stone, the heaviest. We used both a washed material and a dipped pit run gravel. The pit gravel worked well where the large stone was the deepest. Although there was a small amount of dirt in this pit run gravel, we did not deem it to be serious, since the rains washed it out. It was necessary not to get the pit gravel too heavy, as it had a tendency to create a slick surface when packed. The washed gravel worked well on the loose stone as a filler, where the stone had become fairly well packed, providing it was not too coarse. Neither is too much sand desirable, lest it will sift through the stone when dry and cause more loose material than we had to begin with.

Eliminating Short Waves with Drag.—Dragging and rolling should be carried on after the gravel is put on as it was before it was applied. A long drag is essential in taking out the waves and much can be done along this line after the gravel is applied. We used a 4-bladed drag of the wooden type, which was 24 ft. long and about 8 ft. wide. We had expected to pull it with a 5-ton caterpillar tractor but found nothing less than a 10-ton would do it. Even at that we found it to be a very valuable piece of machinery and proved to be a great factor in eliminating the short waves or dips which were not more than 10 to 15 ft. long. Our 12 ft. grader proved valuable also in smoothing the gravel and stone surface. I noticed in one particular instance where the foreman had a 6-ft. grader hitched to and immediately behind the 10-ton tractor which was pulling the loose material from the edge of the road and preventing it from getting into the ditch, and behind the small grader, with a separate hitch to the Holt was a 12-ft. grader which was smoothing down the material brought in by the small grader and in this way had a tendency to fill up the short dips.

Distributor Applying Second Coat of Bituminous Material on Hard Bare Surface

This arrangement worked very successfully.

While the larger trucks were busy hauling gravel for the more extensive resurfacing, we had one and sometimes two of the smaller trucks hauling gravel and the finer stone and spotting up the small depressions and dips which could not be taken care of very well with the larger trucks. It was frequently necessary to place only a few shovels of material in each place. A very good time to do this particular kind of work is imemdiately after a rain or even better during the rain. (Continuous dragging should be done at this time. The old saying is "make hay while the sun shines." Here we will say "make smooth surfaced roads while it rains.")

After having applied approximately 8,800 cu. yd. of stone, 3,400 cu. yd. of washed and plant gravel and 1,500 cu. yd. of local gravel on 12.6 miles of road or an average of 1,906 cu. yd. per mile for all material, we were ready to begin the application of the light grade of tar known as Tar TC in the State specifications.

The Tar.—This tar was shipped to the nearest railroad station in tank cars of about 10,000 gal. capacity. Before unloading the tank cars into the distributor, several measurements of the car were taken to determine the gallonage. The temperature of the tar in the tank car was also taken which was usually from 100 to 105° F. As our contract with the tar company states that the gallonage applied shall be computed on a basis of 60° F. it was necessary to take the temperature data.

Since each tank car was sampled at the plant by R. W. Hunt Co., and samples sent to our testing laboratory at Indianapolis, it was not necessary for us to take samples of each car. We did take a sample, however, from every fifth car, taking 1/3 quart from the top, the same amount from the center and the same amount from the bottom of the car. We mixed these giving us one quart total as a sample to be tested. This was done only as a check on tests formerly made. We went ahead ahead and used the tar on the strength of the former tests.

Leveling Surfaces with Grader After Application of Second Coat of Bituminous Material

Method of Applying the Tar.—The distributor used, was of the pressure type and had a capacity of 750 gal. The distributor was equipped with an oil heater and before the tar was applied it was heated to a temperature of from 115 to 120° F.

After the surface of the road had been smoothed with a maintainer or drag, the first load of tar was applied about June 22nd. The temperature of the atmosphere at this time was about 90° F.

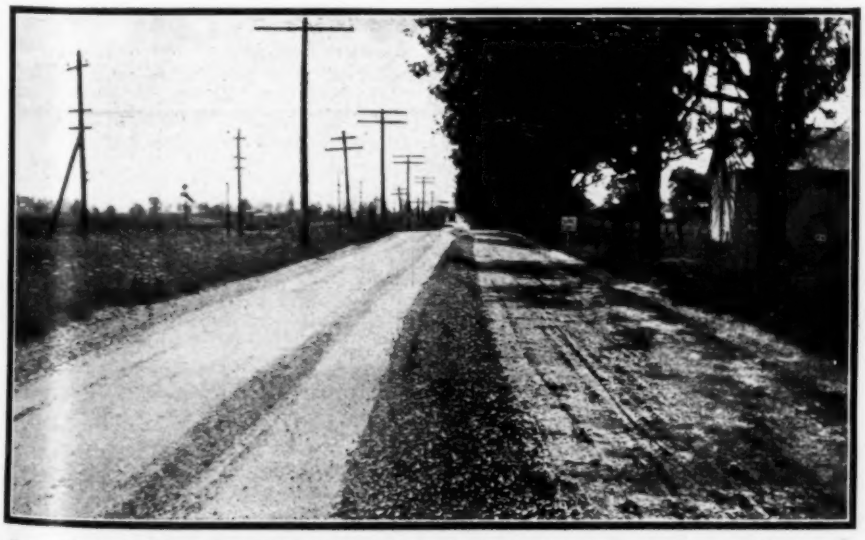
Our method of applying the tar was as follows: One-half of the road or about 10 ft. in width was treated at a time. The first application was made on the loose gravel or stone surface after the twenty foot roadway had been given the proper crown with our crowning drag, three-eighths of a gallon per sq. yd. being applied as a first application, one distributor load covering about 2,000 sq. yd. or 1,800 lin. ft. for a 10-ft. strip.

After the first application had been allowed to penetrate for 1 to 1½ hours, the loose material was scraped or turned from one-half the road over to the other one-half, leaving the hard bare surface exposed It is advisable, when scraping the loose material from one side to the other, to get well beyond the center line of the road in order that the distributor may be sure to cover the entire width with the two spreads it makes on the bare surface. The scraping of this loose material was done with a grader pulled by a truck, care being taken not to get beyond the gravel or stone line at the edge of the road and in so doing, get some dirt mixed with the gravel and stone.

In the meantime, the distributor had applied tar on another 1,800-ft. strip or perhaps on two strips on the loose gravel, depending on the length of the dead haul to the tank car. Three-eighths of a gallon per sq. yd. was now applied, as a second coat, on the surface that had been scraped bare of the loose material. After this application had been allowed to penetrate for 1½ to 2 hours, we then reversed the scraping method and proceeded to move the loose material from the other side over to point just beyond the centerline of the road.

We now had a ridge of loose material, mixed with tar and resembling a sweet potato ridge near the center of the road, and were ready to apply the second coat of tar on the second one-half of the bare road. This completed the first 1,800 lin. ft. of road as far as the application of the tar was concerned, except for a little spotting up which was done after the road was finished and which will be explained later on.

Spreading Tar Mat Over Surface.—After, not less than two hours, we were ready to spread the ridge of tar coated



Second Coat of Bituminous Material Applied on One-Half of Surface After Loose Material Is Scraped to Center of Road

Crowning Drag in Operation, Finishing Surface Treated Gravel Preparatory to Rolling

gravel and stone over the entire 20 ft. of treated surface. It was very essential that we spread the material uniformly and have a uniform depth over the entire surface. We first used a No. 7 grader with a 12-ft. mole board. The blade was set at right angles to the road and to the grader itself, which allowed it to spread the ridge evenly on each side of the center line of the road. The first trip with the grader did not, however, get the material entirely out to the edge of the treated surface and it was necessary to make two or more trips over the surface to insure a fairly even distribution of the stone and gravel.

Crowning the Road.—The loose material was now about 1 to 1½ in. deep over the entire surface, but was not true to the crown of the road and therefore not ready to be rolled. We now used our home-made wooden crowning drag, which is made with two parallel blades about 6 ft. apart and 20 ft. long, or just the right length to reach over the entire width of the treated surface. We had a crown cut in the blades, conforming to the crown wanted and which made the center of the road 2½ inches higher than the outside edges. This drag was now pulled very slowly with a truck, great care being taken to keep the center line of the drag in the center line of the road. Two men followed the truck, in front of the drag, and with shovels, kept the loose material evenly distributed along the front face of the blades of the drag. This caused the surface to be uniform and true to crown. It is very important not to have a shoulder on either side of the metal that is the least bit higher than the metal itself. If such is the case, the ends of the drag will ride this high surface and destroy the uniform crown, which is so essential to the success of the work. If the water is allowed to stand on the finished treated surface, it will destroy the life of the tar and cause it to disintegrate in a short time, hence the importance of not having a high shoulder. We ran a grader ahead of the distributor and cut the shoulders down where necessary.

Rolling Finished Surface.—After we had pulled our crowning drag over the surface three times, we used our 10-ton roller to roll the finished surface.

This rolling was then done, beginning at the outer edge of the road. Sometimes if the loose material is a little light near the shoulders and the tar, seemingly, a little heavy, the roller will tend to pick up the mat. This can be avoided by putting a small amount of water on the wheels of the roller. This can be done by having a tank of water located on top of the roller, above the wheels, allowing the water to drip as needed. If the tar still seems to pick up under the roller, it is best to stay off this particular part of the road until some loose dry material can be sprinkled over the surface. I think that it is very important that we do plenty of rolling and one roller can easily do this and keep up with one distributor.

After the surface had been thoroughly rolled, we called it finished and allowed traffic to use it the day after it was completed. It is better to try to completely finish, at the end of the day, the stretch of road, begun in the morning. If this treated material is allowed to lay in a ridge or even allowed to lay over night with only a first coat of tar applied, it will set to a certain degree and will not work so well or give quite as good results as if worked when first applied. Never, if it can be avoided, let material lay, as mentioned above, over Sunday. It so happened that we were compelled to do this in one or two instances with the result that this part of the road so treated, proved to be too dry and it was necessary to apply a third coat of tar later and which extra coat of tar may be a source of trouble as described later.

Preventing Pickups of the Mat.—In order to play safe against any further pickups of the mat, we had a few stock piles of gravel and stone, principally stone, placed along the roadside to apply on the bleeding places, which are sure to develop with this kind of surface treatment. We used very little gravel however, since we found that 7/8-in. or even 1-in. stone, free from dust, answered the purpose much better. We placed this stone on the bleeding surfaces, which needed it, with a truck if the space was long enough to use a truck load, otherwise it was done by hand. A truck load of 3 yd. covered 1,500 to 2,000 lin. ft. of road for a width of one-half the road.

We also had a few barrels of tar stored along the road to take care of the spots that seemed to be too dry or spots where the mat had begun to ravel. We sprinkled the tar over the dry spots, covering it with a very light coat of stone chips. Where holes developed, we patched these with a lean mixture of stone and tar.

Remedying Shoving of Mat.—After the tar had been down on the road for a few weeks, we noticed, in a few places, that the mat was rolling or pushing ahead of the traffic. This would indicate that we either had too much tar at these places, too heavy a mat of loose material or an excess of sand in the gravel. I think that, in our case, the first and latter conditions, too much tar and too much sand existed.

Crowning Drag Preparing Surface Treated Gravel for Rolling

Method of Applying Bituminous Material on Dry Spots After Surface Treatment Is Completed

To remedy this, we spread 7/8-in. and 1-in. stone over these places, letting the traffic pack it into the tar mat. In many places this was not done until too late, as the shoving and waving had already developed. This was repeated a second and third time with reasonably good results. In one or two instances, where the shoving was excessive, we cut off the high places with a grader. Examination showed that the mat at these places had not adhered at all to the hard base of the road and in some places it was necessary to remove it entirely.

This completed our surface treatment on this section of road.

We have a road treated 20 ft. wide, a road free from dust and, where the work was properly done, a road with a riding surface equal to the average pavement. We expect this road to need attention this coming spring, in fact it is very probable that we will have to give it another light treatment for next summer.

Features That Should Be Observed.—We do not consider this job a perfect piece of work of its class. Our men were compelled to learn from experience how to handle the work and it is difficult to do this the first time without making some blunders. Our experience on this job taught us to observe carefully the following features:

(1) It is very evident that an excess of tar will cause a shoving and waving in the surface while an insufficient amount of tar will cause raveling.

(2) It is easier to correct the deficiency in the tar than it is to correct the excess as it is always possible to add a small amount of additional tar if there is a deficiency in the amount applied; however, if an excess is applied, it is perhaps more difficult to correct the error.

(3) The condition from excess tar can be corrected by covering of the surface with comparatively coarse covering material, saying 3/4 in. to 1-1/4 in., repeatedly, permitting the traffic to hammer the covering into the soft surface. If this is done frequently enough, it would seem that the waving and shoving from an excess of tar can be very greatly reduced if not entirely prevented.

(4) The county hauled by team and wagon, heavy loads of gravel, from a local gravel pit, for a distance of about 3 miles over this road for about two months. This kind of hauling broke up the surface to a considerable extent as this type of surface is not suitable for a heavy traffic with steel tired vehicles.

Costs.—The following is an estimate of the cost per mile of work described, not including the building up of the subbase, which would have to have been done whether we treated the surface or not:

250 cu. yd. clean washed gravel applied prior to treating, at $2.50 per cu. yd.	$ 625.00
Dragging and preparing the surface for tar	100.00
8,700 gal. tar applied, 20 ft. wide	1,000.00
Labor rolling and smoothing treatment surface	150.00
30 cu. yd. No. 4 stone applied as covering coat, at $2.50 per cu. yd.	75.00
Total	$1,950.00

It may be interesting to note the difference in maintenance cost per mile of this section of road for six months after the surface treatment as compared with the maintenance cost for the six months prior to treatment.

Finished Surface Treatment on Bituminous Macadam

Six months prior to treatment.	
200 cu. yd. gravel applied at $2.50	$500.00
Labor dragging daily at $1.50 per mile	175.00
Miscellaneous expenditures	25.00
Total	$700.00
Six months after treatment.	
50 cu. yd. covering applied at $2.50 per yd.	$125.00
50 gal. tar at $0.20 delivered	10.00
Labor patching small holes and miscellaneous work	75.00
Total	$210.00

Comparing the cost mentioned and considering the benefits of a dustless road to the traveling public, we feel that a surface treated road is an economical investment.

Bond of Pile Heads in Concrete Foundations to Be Tested

The Bureau of Public Roads is planning a series of tests to determine the bond strength developed between the heads of foundation piles and concrete foundation seals and to investigate methods of anchoring reinforcing steel to pile heads. It is planned to make these tests at an early date in order to secure information for the design of Federal-aid bridges which have been proposed for the Gulf region. In the design of these bridges special attention is to be given to the pier designs in order that they may be capable of withstanding large overturning moments due to high winds.

Six series of tests are to be made at the Arlington experiment station of the bureau. Short sections of water-soaked timber piles will be incased in blocks of 1:2:4 concrete representing the foundation seal. Plain cylindrical piles and pile heads which have been expanded by means of wooden wedges are to be used and will be pulled from the concrete by means of hydraulic jacks.

The relative effectiveness of different methods of anchoring reinforcing steel to pile heads is also to be determined. These tests will include hacked bars driven into pile heads, bars with foxbolt ends driven into pile heads, and special steel pile rings designed for the attachment of reinforcing bars. The anchorage developed will be determined by pulling the steel from the pile head in a large testing machine.

Motor Vehicles Used 222,915,000 Bbl. of Gasoline in 1925.—The 20,000,000 motor vehicles in use in the United States in 1925 consumed 222,915,000 bbl. of gas in 1925, according to figures of the Vermont State Chamber of Commerce. Computed on the basis of 55 gal. per barrel, the total gasoline consumed, in gallons, was 12,260,325,000. On the basis of twenty million motor vehicles this gives an average gasoline consumption, per vehicle, of 613 gal.

Snow Removal on County Roads

Experiences in Wayne County, Indiana, Described in Paper at Annual Road School, Purdue University

By W. M. TONKEL
County Highway Superintendent, Fort Wayne, Ind.

There are various problems to the removal of snow and one of the most serious, in my opinion, is the snow drift. To solve this problem it is necessary to give it a study from the experience of preceding winters. For instance, snow drifts deeper in some places than it does in others and there is a reason for deeper drifts and it is necessary to locate this condition the winter before so that preventative methods can be applied prior to the snow season.

Causes of Snow Drifts.—A snow drift will usually take place where the wind is checked by some obstruction. The snow is deeper in drifts for the same reason that sand bars are formed in streams where the current in the water is not strong enough to carry the sand and silt, thus allowing the sand and silt to drop to the bottom.

We usually find snow drifts more frequent on our north and south roads. This is due to the prevailing direction of our winds which are generally from the west, together with the fact that obstructions such as fences, hedges, etc., are usually found paralleling road. Therefore, an obstruction on the west side of the road is much more objectionable than one on the east side.

You will find that wherever there is a snow drift that such things as a rail or picket fence or hedge fence are on the side of the road that checks the current of air just enough to let the heavier particles of snow drop.

Hills of high banks are often the cause of snow drifts. A careful study of the cause of snow drifts during the preceding winter will be of great value in solving the problem for future winter seasons. It must be kept in mind that the direction of the wind is a controlling factor in the location of drifts. Snow drifts cannot always be eliminated. Neither can a heavy fall of snow be prevented and this compels us to deal with the subject later from another point of view.

Methods of Preventing Drifting.—The removing of obstructions which cause drifts can be determined, as I said before, by preceding winters. This frequently can be done by having low trees trimmed some distance from the ground and fences which cause this condition can be discouraged from use by the farmer. However, we cannot always in justice to the farmer tear down fences he has built at this particular point. However, the seriousness of the case will frequently justify the removal of certain objectionable fences and a wire fence might be suggested and built at this particular place.

A board, picket or hedge fence should not be closer to the center of the highway than 100 ft. This will give plenty of room in most cases for snow to settle before it touches the highway. Weeds and brush on road shoulders or outer edge of right-of-way should be kept cut and trimmed. The higher the road bed the less will be your trouble from drifting snow. Hence, in designing a great deal of consideration should be given this feature. In constructing a road it may be elevated at the point where drifts are likely to form.

Snow Fences.—Of course we will not always be able to remove a hill which happens to be the cause of snow drifts. There is one way to prevent such drifts in this case and that is the erection of snow fences or snow gates as some call them.

Now in some cases it is advisable to erect a stationary snow fence, but in other cases it would be an injustice to the farmer to take up certain parts of his land for this purpose, which would hinder him from using same for the growth of crops.

In this instance I would suggest a portable fence; a picket fence with pickets placed close together may be temporarily constructed for this purpose and can readily be removed, for it can be detached from its rails and laid away until the next winter.

Snow Removal Methods.—There are various methods of removing snow from the road. First, the use of a snow plow pulled by horses or tractors or attaching same to the front end of motor trucks. My suggestion on this would be to start the plow down the center of the road and open up traffic as quickly as possible and then return and throw the snow from the sides as far over into the ditch as possible.

An ordinary grader is an excellent machine for scraping snow from the highway, iron shows being placed under the blade to prevent gouging in the pavement or catching some slight projection in the road surface. The use of a heavy grader is desirable so as not to be shifted sidewise when under heavy load. A "V"-shaped snow plow is often used for opening up tracks in road. This can be used where depth of snow is too great for use of road grader. It will of course be necessary to use enough horse power to pull both the grader and the plow through the deep snow. A snow plow attached to the front end of a motor is used to considerable extent but it cannot be made to operate in very deep snow or drifts as in the case of the road grader and the horse. There is also the power driven rotary sweeper, similar to that used by electric railways to clean their tracks. Owing to the fact that there is a great demand each year for cleaning snow from the road it is possible that machinery will be developed for each specific case in the near future.

It is my experience that there is nothing at the present time that can deal with the 5 or 6 ft. snow drift exceping by some kind of a snow plow, that is, driven by some kind of a caterpillar tractor. However, these drifts are not too frequent and in such places a track made just the width of the road and then working out the sides with other machinery can be employed. My suggestion of course at all times is to clear the road from berm to berm of any snow on the surface, because it is quite dangerous to expect traffic to continue down one track of highway and in most cases where the approaching machine turns out for the on-coming machine they are liable to skid or otherwise lose control of their machines. Throwing snow completely over into the ditch is another important feature because when this snow melts it is less apt to depreciate the berm.

It has been our experience that the expense of snow removal in Allen County by use of the old methods of hand labor was enormous as compared to the cost at the present time. I would estimate that in 1918 we paid approximately $15,000 for the removal of snow, but by the use of preventative methods, as well as the result of procuring machinery for this purpose, we have been able to reduce this figure to not more than $2,000 per season.

The one thing that must stand out most prominent is the necessity of using preventative methods.

Of course the question of snow removal is of vital importance only to those who are geographically situated, where snow falls in quantity, in the northern part of the state, but it should concern each and every one of us, for we may not always be in the same location throughout our lives, and knowing what to do if confronted with problems of this sort is very advantageous to the success of a good road superintendent.

A New Use for Beans

In constructing a pier of the Portland Avenue bridge in the city of Beloit, Wis., considerable difficulty was encountered in keeping the water out of the excavations. The water pressure was not great enough to crowd together the joints in the heavy steel sheet piling sufficiently close to make them anywhere near water-tight. In addition the area outside of the steel sheeting had been puddled with cinders instead of clay, which was extremely hard to obtain at that season of the year. According to Badger Highways the problem of making the coffer dam watertight was solved by pouring ordinary navy beans into the joints in the sheeting. After soaking and swelling not much further trouble was encountered from incoming water.

The Highway Engineer and Safety Traffic

Desirable Conditions of Design and Construction Outlined in Paper Presented Feb. 18 at 13th Annual Conference on Highway Engineering at University of Michigan

By E. W. JAMES
Chief, Division of Design, U. S. Bureau of Public Roads

When an engineer builds a structure intended for the use of the public his responsibility for safety in the use of that structure does not seem to me to involve a very fine point in professional ethics, but quite the reverse. His responsibility for the safe use of the structure within certain limits appears rather obvious.

The Integrity of Professional Work.—This same kind of question involving the integrity of professional work has been raised and answered, at least by implication, in many professions and in many ways. Doctors of medicine and surgeons are held responsible within practical limits of their professions for errors of malpractice or carelessness in prescribing or operating. In connection with steamboat and steamship construction and operation there is a variety of responsibility recognized by the courts, in government regulations and inspection service. Rules governing the determination of the position of the Plymsol mark are established and loading rules are in force under practically every national steamship registration. Standards for boiler construction and inspection service are established by governments and measures for the safety and health of crews and passengers on ocean steamships are provided for either in the navigation laws or in suitable regulations of practically every nation. Laws covering the details of industrial insurance provide for safety devices in manufacturing plans and requirements of boards of health control the operating conditions in a great many hazardous industries. There are mine regulations for the operations underground, and perhaps the most conspicuous instances of measures provided for public safety are those in connection with railway and public utility operations. Violations of proper standards in any of these lines is frequently followed by recognition in the courts of the right of the sufferer to substantial damages.

These conditions represent the crystallization of public opinion on the side of safety, and however careless of human life and of property we may appear from the pages of the daily press, there is no doubt that the law and the courts are also generally on the side of safety and the guarantee of safety. The weight of opinion and the dictates of ethics are both against the man who plans or operates a dangerous device for public use.

Work of Highway Engineer of Great Importance.—The work of the highway engineer has never been so flagrantly at fault that it has aroused any generally hostile public opinion, except possibly in a few scattered local cases of no great prominence. But the work of the highway engineer has during the last 15 years risen to such a place of importance that it now furnishes service which may be compared conservatively in magnitude and importance with that furnished by steamship lines, river steamers, railroads and other public utility corporations. The demands made upon the highway engineer are increasing more rapidly than they ever increased in the case of these other services and if he is to keep abreast of the demands ad satisfactorily meet the requirements which the public is justified in expecting, he must take special cognizance of his responsibility for the safety of that public in all the details of his work. He must recognize that roads originally designed for the convenience of the pedestrian, the pack horse and the relatively slow moving horse-drawn vehicles, are now continuously traversed by heavy and rapid motor traffic operated by all sorts and conditions of men.

The operators of motor vehicles are the general public, and the variety of ability of motor and mental reactions, and in the equation of personal judgment, is almost without limit. The equipment which the highway engineer furnishes is going to be used in a considerable measure by the unskilled as well as the skilled and the devices he builds should be equipped with every possible detail for the assurance of safety.

Proper Use of Highways.—Right here a limiting distinction must be made in defense of the highway engineer that flows directly from the fact that unskilled and improper use of a highway may obviously be made by a careless driver. We must always distinguish between the proper and suitable use of the road and the contributory negligence that flows from any other use.

I recall an interesting circumstance that I once discovered in an important county of a southern state. The county roads were in bad condition and the bridges were in worse condition. In certain inspections which I had to make I discovered loose and broken floor boards. In a few cases single floor boards were entirely gone. In one instance a tension member in the lower chord of a truss was so nearly rusted through that I snapped it by swinging on it with my weight.

In another case an entire lower panel connection was broken so that the entire truss had sagged sufficiently to be visible to the eye. The roads were constructed with deep straight cut ditches that would wreck any vehicle slipping into them and practically the best surfaces on the roads were sand-clay so slippery in wet weather that it was difficult for the driver of an automobile to stay in the center of the road.

Conditions were so promising for accidents that I asked the county judge how often they had accidents and whether the county suffered severely because of damage claims supported by the courts. He told me that they had a clever county attorney and rarely had any damages to pay. He said the attorney was always able to prove contributory negligence and his best argument was that the people of the county knew how bad the roads and bridges were and if they got into trouble and had an accident in the face of this knowledge it was their own fault.

Design Factors for Reducing Dangers.—Today the traffic on our highways is by no means confined to those who know the road. Boundaries of a county used to confine a large per cent of the traffic; now the boundaries of a state are by no means wide enough to set limits to something like 10 or 15 per cent of the annual traffic on our highways. In designing and constructing roads the highway engineer has many details to consider which, if neglected, may introduce serious danger.

The first in order of consideration are those involved in alignment both horizontal and vertical. Horizontal alignment involves curvature and, especially in high-class construction, the greatest care should be exercised in designing such details. There was a time in our early history of railroading when it was believed that trains could not be operated if there were curves in the line, but the engineer now has considerable latitude in his choice of details and the wise exercise of that choice can do much to make the road safe for normal use.

With motor traffic operating at 30 miles an hour or higher speeds no engineer can be excused for using flat, narrow or sharp curvature in his road design, and it is encouraging to see that easement, widening and superelevation are included more widely in current practice year by year. These are mathematical details of design sub-

ject to exact treatment, and an effort is now being made to standardize practice as far as possible for these features.

Vertical alignment involves gradients and vertical curves and the details of these elements of the roads are of the greatest importance to safety. Vertical curves may be so designed as to produce very dangerous points on the highway because of shortened vision and long, steep grades may lead the unwary driver into a serious accident. The reduction of curvature and grades entirely aside from the element of economy involved should be made the general rule of practice and exercised under all possible conditions.

Traffic Lanes.—In view of the constantly increasing traffic the width of surface may also be an element of danger. We sometimes forget that our old 14 and 15-ft. roads were built for horse-drawn traffic that operated at a speed of six miles per hour or less that did not require an especially quick eye or exact judgment of distance to pass another vehicle. Today momentary loss of control may result when a fast moving car passes another and the driver miscalculates his clearance and slips one front wheel off a hard pavement into a soft or loose shoulder.

The Hoover Conference on Street and Highway Safety recently recommended a width of 10 ft. for each lane of traffic and this requires a minimum width of 20 ft. for a two-way road. The engineer who designs his road too narrow in the face of existing conditions opens himself to serious criticism and responsibility for accidents.

Another feature of our highways which are elements of danger are the junctions and intersections that occur so frequently. Our highway network is everywhere in the east and central states a finely woven fabric and there are highway intersections in many states at every mile and frequently at the half and quarter section points. Besides these junctions and intersections with other routes there are intersections with other railroads and with streams. These latter involve some of our most expensive work and are rapidly coming to represent some of our most advanced practice.

Railroad Grade Crossings.—With respect to railroad intersections, the grade crossing will doubtless be with us except on main roads of the first importance. Figured on the basis of chance and measured in terms of human life there may be a reasonable doubt whether we should ever undertake the general elimination of all railroad grade crossings, but there can be no question that eventually on all main roads intersecting main railroad lines, public safety will demand the elimination or adequate protection of practically every railroad and highway intersection. The work so far done in this line is gratifying. On the federal aid system alone there have been eliminated approximately 1,800 grade crossings and the number where watchmen or automatic protection has been installed is very much greater. The engineer who recognizes his responsibilty to the public should cast the weight of his influence with every reasonable provision for grade elimination programs and when he is entrusted with the task of designing such an elimination he should be sure that his remedy is safer than the condition he seeks to correct.

It is astonishing what suggestions have been made for the elimination of danger at railroad grade crossings. A request was once received at the Bureau of Public Roads that we compute for the inquirer the necessary height and length of a hump or "thank-you-mam" to be built into a pavement with the purpose of throwing a vehicle which approached a railroad grade crossing at a greater speed than 30 miles an hour. The chances of death in such a man trap were so great that we questioned the sanity of the person who had proposed it as a solution for grade crossing dangers. We have had a variety of designs submitted to us involving sudden stops or short circuitous curves planned to force a slow speed of approach to grade crossing. Obviously, the total hazard to all traffic in any such device is much greater than the hazard of meeting a train at the crossing. In practically all of our eastern states the density of traffic is such that grade crossing elimination will no doubt be rapidly speeded up in the near future. New York State has recently authorized $300,000,000 in bonds for this work and the programs in the vicinity of large cities are more and more encouraging each season.

Stream Crossings.—At our stream intersections we build bridges. Some of these are standing as the finest monuments to our highway engineers. Our standards of practice with respect to bridge construction are perhaps more nearly abreast of current demands than almost any other details of our work. To be sure, there are many old structures existing which have come down to us from a past which represents much lower demands of traffic than the present, but the amount of first-class new work which is being done represents a very large percentage of the total. The part failure of a bridge can be so little distinguished from its total failure that there has been little difficulty in securing adequate strength, but there are other details promoting safety which must not be overlooked, such as width, clearance, suitable approaches and substantial guards to the traveled way. The omission of felloe guards should never be permitted. These are too valuable a protection both to the bridge structure itself and to the traveler. The width of bridge floor between curbs or felloe guards should never be less than the approaching pavement and the approaches should be direct and with easy gradients. These all represent elements of safety which highway and bridge engineers must recognize if they are alive to their responsibilities.

Highway Junctions.—Junctions with other highways constitute points of danger and in some instances the conditions are so serious as to demand special and expensive treatment. It is probable that there will be an increasing number of highway grade crossing eliminations. In the work now projected around New York a considerable number of these are proposed. Others exist in Washington, Chicago, St. Louis and San Francisco. Some have been introduced as convenient adjustments to meet the existing topography, but others are outright construction for the purpose of increasing the efficiency of densely traveled highways and insuring a high degree of safety. Such eliminations will undoubtedly be encouraged as a measure of economy. When we consider two intersecting highways carrying traffic to full capacity, the interruption due to the alternate stoppage of traffic reduces the combined efficiency of those highways at least 50 per cent. With increasing traffic we shall find ourselves much encouraged in eliminating highway grade crossings for the sake of safety.

The engineering details of highway grade crosisng elimination have not received a great deal of study and the best designs have undoubtedly not yet been produced. There are certain principles in this work which must be recognized in a thoroughly satisfactory layout. Complete access must be given from each lane on traffic in one intersecting route to both of the lanes of traffic in the other intersecting route. This must be done without introducing any additional intersecting lines of traffic; without fouling any line of traffic; with due care that each traffic lane is relieved of the departing traffic before additional congestion is created by entering traffic. A few studies along this line have already been made in the Bureau of Public Roads, but no actual case of highway grade separation has yet permitted the application of these principles.

Separation of Highway Grade Intersections.—Where highways intersect at grade and the expense of such grade separation is prohibitive, the introduction of the roadpoint or rotary intersection offers a solution of considerable advantage. Again we are without adequate or sufficient data for a study of rotary intersection design. The controlling details appear to be the radius of the interior circular parking, or possibly the radius of the center line of the circular pavement; the relation of the width of pavement in the circle to the sum of the widths of the radiating roads; and of course the amount of traffic and its distribution with respect

to peak traffic on the intersecting routes and at different hours.

From observations in the city of Washington in a number of circular intersections, some carrying as high as ten radiating streets, it appears that the shorter the radius the lower the capacity of the circle, other details remaining the same. The theoretical width of pavement in the circle should be 25 per cent of the sum of the widths of all radiating roads, but for the reason that we do not find all of the radiating roads carrying peak traffic at the same time, circles with considerably less than the theoretical width of pavement appear to carry radiating traffic without congestion.

The Pavement Surface.—An engineer's responsibility for making the highways safe for traffic does not cease by any means when he has incorporated into his design every possible detail toward this end. He must see that the execution of the work is so carried out that the surface itself in its finally completed condition will be as safe as possible. His incentive to this end is not merely the safety of traffic but also the integrity and protection of the road surface, and in going to considerable expense for safety's sake he finds himself justified by a resulting pavement of greater durability and consequent longer life. It is essential first that the finished condition of the surface be regular; that it be free from inequalities; a wavy condition or any unevenness that will tend to start undue vibration in a traveling motor vehicle. The serious effects of such vibration have been disclosed by our impact studies and it behooves the engineer who conscientiously seeks to construct a satisfactory and safe pavement to adopt such methods of construction and such refined tests for the finishing of a pavement surface as will permit driving at any legal speed without danger to the vehicle and without risking serious damage to the pavement. However difficult it may be to secure contractors capable of properly finishing a pavement and disposed to give this detail the proper attention, the engineer can hardly give this matter too close attention or insist too strongly on satisfactory results. The test for regularity of surface which is now being written into most of the standard state specifications requires that when a straight edge is laid longitudinally on the surface no depression shall be greater than one-sixteenth of an inch per foot measured to the nearest point of contact of the straight edge. This condition can be obtained by careful work on concrete, brick and mixed bituminous tops. It is more difficult to obtain on bituminous macadam, but it is not thought that the condition is too rigid even for this type. A pavement as smooth as this requirement produces will practically eliminate any danger of losing control of a car, driving at any reasonable speed, and likewise practically eliminates undesirable impact due to heavy trucking.

It is highly desirable also that pavements have as great a continuity as possible. This applies not only to the general character of surface but also to width and condition. It is at once seen that to meet this requirement will involve most of our highway departments in a considerable amount of reconditioning and reconstruction of old pavements. It must be recognized, however, that this matter involves the entire highway program both with respect to financing and the location of work, but its importance is such that the Bureau of Public Roads is now seriously considering taking active steps to induce the states to give this matter more careful thought and take advantage of that clause of the Federal Highway Act which provides aid for reconstruction. It is inevitable that continuity of type cannot be secured and, in the selection of types, should not be secured for economic reasons, but it emphasizes the need of proper care where dissimilar types join, and relatively better maintenance on those types which are less durable in order that the general character of the surface may be kept reasonably uniform.

It is esential also that pavements be selected and constructed with the point of view of reducing slipperiness to the lowest possible degree. In dry weather practically any modern pavement furnishes a satisfactory surface from the point of view of traction and the coefficient of friction is so high that we experience little difficulty, but in wet weather or in cold weather when sleet or ice forms on the pavement conditions may become exceedingly dangerous. The presence of foreign matter on the surface, especially clay or leaves, makes the pavement exceedingly slippery, but so far it has been impossible to take care of these details satisfactorily through the usual maintenance operations. The engineer, however, can reduce the danger by keeping the crown of his pavements as low as possible, at the same time securing adequate drainage, and by proper selection of types on grades exceeding 5 per cent.

Recently, some investigations have been undertaken to develop the changes in the coefficient of friction due to the wet condition of the pavement surface but these studies have not yet advanced to a point where conclusions may be safely drawn.

It is obvious from what has been said in this paper that these desirable conditions of design and construction cannot everywhere be secured at once. In every state highway system, even in a system so small as 1,000 or 1,200 miles there will for many years be sections in too good condition to warrant reconstruction, but which contain curvature, gradient, and other details which are unsatisfactory. So long as these exist and so long as the public has a disposition to contribute negligence in the use of the highway there is another duty of the highway engineer which I must finally describe as an esesntial part of his work in making the highway safe. This is the use of proper warning signs, which will inform the traveling public of the conditions to be met on the highway.

For years to come we will have grades somewhere that are so steep as to demand cautious driving. There will be curves where the line of sight is too short; there will be bridges too narrow; underpasses that are low and crooked; lack of continuity in the surface that produces points of danger, and grades which, though not unduly steep, are so long as to threaten serious heating of brakes and possible loss of control by a driver.

Standard System of Marking.—Practically every state has recognized the need for such precautions to the traveling public, but the matter has never until comparatively recently received systematic attention. The work of the Joint Board on Interstate Highways and the action recently taken by the Association of State Highway Officials has now produced for the use of the states a standardized series of warning and caution signs that deserves the attention of every state highway department. The designs for these signs have been very carefully studied, and their shapes, size and visibility have been determined after careful work by a number of cooperating agencies, among which are the Association of State Highway Officials, the Bureau of Public Roads, the Bureau of Standards, the General Electric Company and the American Engineering Standards Committee. Important work was done by several of the states, notably Ohio, Indiana and Illinois, and it is believed that the general scheme has been worked out in a satisfactory and very practical manner.

In developing these signs a number of definite principles have been followed. These comprise a definite color code, a definite shape, a printed legend and where possible a symbol to indicate the nature of the hazard which the driver may expect to meet. The series of signs is made up of a number of groups known as directional signs, caution signs, warning signs and restrictive signs.

The Signs.—The directional signs are in white and black, rectangular in shape and are used to inform the traveler of his location and of the distance and direction to other points. The caution signs have a yellow background with black legend or symbol. The square caution sign is used to indicate hazards which are not inherent in the road itself, but which are intermittent or which may come upon the road from an outside source. Such signs are used to indicate the presence of cross roads,

schools, churches, hospitals, etc., where the car should be brought sufficiently under control to permit of an almost immediate stop, if necessary.

The second degree of caution is indicated by a diamond shaped sign which is a square mounted with the diagonal in a vertical position. This sign is used to indicate conditions inherent in the road itself which demand caution on the part of the driver, and is the sign which will be most commonly used. Such signs are for the purpose of indicating the existence of curves or hills where care must be taken in driving; narrow pavements; narrow bridges, low headroom at underpasses; reversed curves and winding roads, and any other condition which may require particular attention or slackening of speed. Railroad grade intersections are indicated by a circular caution sign having the same color code and indicating whether one or more tracks are to be crossed. Finally an octagonal sign is used to indicate the need to stop before proceeding further.

Uniformity of Marking System.—There is now in preparation a manual which will soon be available covering the use and erection of these signs, and by following it the several states can develop a system of highway marking which will be uniform throughout the country regardless of state or county lines. Already over 40 states have indicated their intention of adopting this series of signs for a selected group of roads and the simplicity of the system is such that the public will very soon learn the significance of the signs and will know that they are everywhere used under the same conditions for the same purpose. The uniformity of the scheme is one of its greatest points of value. The signs act as instructions to the traveling public and when instructions are given everywhere alike in the same terms, the effect produced will be as strong as it can be made by any practicable system. The constant repetition of the same instructions will have its psychological effect on the driver and he will find himself almost unconsciously responding to the reaction produced by the warning or caution sign. If he cannot read and is color blind, he still has the shape of the sign and in some cases the symbol to indicate the nature of the hazard. If every road could be built at once without any points of danger and if every driver would drive carefully it might be possible to dispense with the use of any warnings or instructions to be cautious, but until that time comes there will always be a need for a system or road marking such as that provided in this series of signs.

The Association of State Highway Officials has undertaken to introduce these signs on a comparatively limited mileage of highways, hoping by this means to secure an extension of their use eventually to a much greater mileage of state and federal aid roads. Already many counties and towns have taken steps to introduce the signs and approximately 10,000 working drawings of the designs have been supplied to the states, manufacturers and others interested in their use. A Sectional Committee of the American Engineering Standards Committee is now working on the general problem of introducing uniformity in city markers of all kinds, including pavement markings and luminous signals. This committee has indicated its purpose to adopt this same system of marking for city use, using probably a sign of smaller size which will have sufficient visibility on city streets and park roads.

A careful consideration of this system of marking is strongly recommended to every highway engineer whether he is engaged in state, county, or city work, and every engineer who is alive to his responsibilities as a public servant furnishing a utility for the general use of the traveling public will include this feature of highway safety in his bill of materials and estimate for a road project. The engineer must realize that his responsibility extends to every detail of design, construction and operation and should leave no step untaken that will increase the safety of the highways which he builds.

$1,123,000,000 for 1927 Road Work

The 1927 programs of state highway departments call for a total expenditure of $1,123,000,000, according to reports received by the U. S. Bureau of Public Roads. These reports cover the proposed work of 47 states. On account of the uncertainty of supporting legislation no estimate of the season's work is possible as yet in Connecticut.

The estimates given out by the U. S. Bureau of Public Roads indicate that 26,841 miles of new road will be constructed and 239,847 miles maintained.

In carrying out the programs it is expected that there will be expended under the supervision of the state highway departments in the 47 states a total of $648,483,000.

In addition to the state expenditures approximate estimates indicate that counties and other lesser subdivisions of government will expend during the year $475,000,000.

Of the expenditures by the state highway departments of the 47 states approximately $421,000,000 is the estimated amount for road construction and, according to present plans, more than $56,000,000 additional will be spent for new bridges. For reconstruction of existing roads it is estimated that the expenditures will be nearly $27,000,000, and for maintenance approximately $126,000,000.

The estimated mileage of new state highway construction contemplated during the year, subdivided by classes of surface, is given below:

Estimated Road Mileage to Be Built by State Highway Departments

States	Earth Improved	Sand-Clay, Gravel and Macadam	Asphalt, Concrete and Brick	Total Mileage
Alabama	67	279	60	406
Arizona	30	67	3	100
Arkansas	250	300	30	580
California	.....	65	15	80
Colorado	32	49	43	124
Delaware	.....	15	60	75
Florida	275	100	400	775
Georgia	100	250	156	506
Idaho	25	105	15	145
Illinois	219	.....	1,036	1,255
Indiana	40	100	275	415
Iowa	308	519	263	1,090
Kansas	836	522	240	1,598
Kentucky	400	330	170	900
Louisiana	.....	450	50	500
Maine	.....	359	55	414
Maryland	.....	35	89	124
Massachusetts	.....	50	190	240
Michigan	50	165	200	415
Minnesota	490	390	127	1,007
Mississippi	231	238	55	524
Missouri	450	350	122	922
Montana	.....	250	1	251
Nebraska	600	700	10	1,310
Nevada	.....	145	4	149
New Hampshire	10	75	15	100
New Jersey	10	.....	110	120
New Mexico	45	125	9	179
New York	.....	.....	1,006	1,006
North Carolina	.....	500	150	650
North Dakota	521	521	.....	1,042
Ohio	50	500	300	850
Oklahoma	300	400	150	850
Oregon	125	125	2	252
Pennsylvania	100	400	800	1,300
Rhode Island	.....	.....	44	44
South Carolina	.....	350	250	600
South Dakota	.....	450	.....	450
Tennessee	223	113	193	529
Texas	600	1,000	200	1,800
Utah	.....	93	7	100
Vermont	.....	100	10	110
Virginia	50	100	75	225
Washington	170	165	50	385
West Virginia	200	150	75	425
Wisconsin	.....	1,195	374	1,569
Wyoming	150	200	.....	350
Totals	6,357	12,395	7,489	26,841

Proposed Michigan Road Program Calls for $54,790,500

Frank F. Rogers, State Highway Commissioner of Michigan, has submitted to the state administrative board a tentative program of state trunk line and bridge construction, covering a period of approximately 3 years, and calling for an estimated expenditure of $54,790,500. Of this total $47,500,000 is for roads, $1,400,000 for 24 grade separation projects and $5,890,500 for bridges. The following summarizes the proposed road construction:

	Miles
20-ft. Concrete	1,000.30
30-ft Concrete	12.75
40-ft. Concrete	22.00
Gravel	225.75
Grading, Drainage and Shouldering	38.50
Asphalt Surfacing	19.50
Penetration Macadam	10.00
Water Bound Macadam	12.00
Miscellaneous Construction	52.00
Total Mileage	1,392.80

Pennsylvania Aggregate Storage Requirement

The Pennsylvania Department of Highways has notified contractors that it is the policy of the department that the areas over which aggregates may be piled or stored are not properly prepared until the area on which the material is to be stacked or stored has been entirely covered with planks not less than 2 in. in thickness, or sheet metal plates which shall be laid closely together.

Railway Engineers Discuss Grade Crossings

Committee Reports on Subject at Recent Convention of American Railway Engineering Association

The Committee on Grade Crossings, reporting to the 28th Annual Convention of the American Railway Engineering Association, brought out a great deal of interesting data that bears on the subject of grade crossing protection and elimination. The report covered (1) revision of the manual, (2) methods of apportioning the cost of highway improvements adjacent and parallel to railroad rights-of-way, (3) the value and safety of various forms of grade crossing protection as against watchman protection, (4) relative merits of various types of mechanical and power operated grade crossing protection devices, and (5) laws and regulations affecting the apportionment of federal aid; (6) the proper form and character of division of costs of separation of grades as between the railway, state, county, municipal or other corporation. The committee also reported progress on the subject of (a) the character and extent of unnecessary or duplicated highway crossings over railways with methods for their combination and consequent elimination, and (b) the economic aspect of grade crossing protection in lieu of grade separation.

In reporting on subject 4, the committee stated its inability to decide upon the merits of each kind of protection at this time.

Apportioning Paving Cost.—In reporting on the methods of apportioning the cost of highway improvements adjacent and parallel to the right-of-way of a railroad, the committee called attention to the trend towards financing highway improvements by means of license fees and a gasoline tax. This, naturally, has a bearing on the costs of paving, since property taxes for the purpose are reduced. Four states, the report brought out, have no gas tax—Illinois, Massachusetts, New Jersey and New York. Anticipated collections from a gasoline tax during the past year were estimated at $170,000,000 by the committee. Of the total gasoline tax for the first six months of 1926, the state highway departments received 65 per cent, 23 per cent was spent on county and local roads, 7 per cent went for state and county road bonds, and the remaining 5 per cent was spent on miscellaneous work. In all states imposing a gasoline tax, the rate varied from 1 to 5 ct. a gallon, with an average of 2.39 ct.

Who Should Pay?—This method of raising money, together with motor license fees, the committee stated, should be used to bear the greater cost of highway improvements, for thus the work is paid for by those who are directly benefited. It was felt, however, that where railroad property was directly benefited by an improvement it should bear a part of the costs of such improvement.

> No one is more interested in the subject of grade crossings than the highway engineer. Whether a grade separation is feasible, or other protective measures may be necessitated is a question that arises frequently. Current thought on the subject among railway engineers would therefore be of real interest. The experience and the attitude of the railway man is well mirrored in the report of the Committee on Grade Crossings of the American Railway Engineering Association as submitted at the 28th Annual Convention held last March in Chicago. This committee report is therefore abstracted in these pages for the benefit of those whose work brings them into daily contact with the problem.—The Editor.

Gasoline taxes were first imposed in 1919, when four states adopted this form of taxation and derived a revenue of a little more than $1,000,000. The practice is now general and the large revenue derived is one of the most important sources of highway income.

The United States Department of Commerce has recently made public a report showing that for 1925 the income from gasoline taxes amounted to $87,353,194 and income from license fees $198,710,310, making a total of $286,063,194 derived from gasoline tax and motor license fees. During this period there was spent $481,700,000 for highway construction and $144,000,000 for maintenance of existing highways, making a total of $625,700,000 for state highway purposes. Therefore, taking the year 1925 as an index, approximately 46 per cent of the cost of highway construction and maintenance was financed by receipts from motor vehicle taxation. On the basis of the first six months of 1926, state highway departments will receive approximately $110,000,000 from gasoline tax last year, as against $87,353,194 received in 1925, or an increase of approximately 30 per cent.

Practice in Various States.—During the past year a re-canvass has been made by inquiry directed to the public service commissions of the states:

(1) As to the practice of the state authorities in the apportionment of federal aid funds to the various highway projects.

(a) Hard surfacing.
(b) Grade crossing elimination.
(c) Grade crossing protection.

(2) How is the expense of a grade crossing elimination project divided as between federal aid, the state, county, township and the railway company or companies interested?

Replies are indicated below by states:

Alabama.—"The State Highway Department of Alabama at a conference with the railroad officials representing railroads operating in the state of Alabama, in 1924, formulated and adopted a policy of cooperation with the railroads for the elimination of grade crossings on our trunk highway system, which policy was concurred in and adopted by the representatives of the railroads, and the highway department and the railroads have been operating under this agreement ever since very satisfactorily and successfully.

"The agreement is to the effect that wherever possible, the State Highway Department will eliminate grade crossings by relocation in its construction program, such relocations avoiding the crossing of tracks if possible, if not possible, seeking a point where the topography permits a separation of grade crossings, either by an overhead bridge or by an underpass; the railroad company participating with the state in the amount of 50 per cent of the cost of the bridge required to make such separation, whether it be a highway bridge or a railroad bridge. This mutual cost covers only the bridgework proper, that is to say, the abutments and on work between abutments. Any grading that may be necessary to elevate or depress the highways so as to go under the railroad or to raise the bridge over the tracks is borne by the state alone.

"Federal funds are used on federal projects in connection with the construction of overhead or under-grade structures in the same manner as they are used on other work done by the State Highway Department, that is to say, the Federal Government participates in the cost of work actually done by the state."

Arizona.—No fixed policy has been adopted as to division of cost on grade separation owing to the few instances of such projects. However, in some pending agreements with railroads, it is proposed that the state shall bear 65 per cent and the railroad 35 per cent of the cost of the project grade point to grade point in either an over or under grade crossing. This also includes the railroad bridge in the case of a highway undercrosing. Federal aid funds are absorbed in the state funds.

Arkansas.—No rules or regulations adopted concerning highway crossing design, protection or elimination.

There is a stop law that every motor propelled vehicle shall stop at such

crossings in each county as are designated by the county judges.

California.—Federal aid funds are made a part of the state funds and no direct allocation made to grade separation projects. However, due to the unappropriated public lands within the state, federal aid may be made to pay for 60.05 per cent of a project that is joint with a railroad.

Colorado.—No fixed policy has been adopted in applying division of cost. Federal aid funds are absorbed in the state funds.

Connecticut.—Federal aid funds are absorbed in the state funds. By state statutes grade crossing elimination costs are borne 25 per cent state and 75 per cent by the railroad or railroads affected.

Delaware.—No rule or policy as to division of cost of grade separation adopted. Federal aid funds are absorbed in the state funds. No particular assignment to a given project.

Florida.—Federal aid funds are absorbed in the state funds. More grade separation projects built without the application of any federal aid money than those where any part of such funds are assigned. In the case of a grade separation highway overcrossing the cost is divided equally for the bridge over the railroad, including the abutments. In the case of an under crossing the expense of excavating the existing embankment and the structure carrying the railroad is divided 50 per cent to state, 50 per cent to railroad.

Georgia.—No policy reported as to handling of federal aid or division of expense in grade separation.

Idaho.—Federal aid funds are absorbed in the state funds. The division of expense for grade separation is 50 per cent to the railroad and 50 per cent is taken up by the state and county.

Illinois.—No rules adopted for apportioning expenditure for grade separation, each case handled on its merits. Federal aid funds absorbed in the state funds.

Indiana.—By act of legislature expense of grade separation is divided 50 per cent to state, 50 per cent to railroad. Federal aid funds are absorbed into the state funds. A county or township may appropriate funds to assist in any given highway project, but all such assistance goes to the state.

Iowa.—No consideration is given to federal aid funds by the state in their negotiations with a railroad on a grade separation project.

No fixed policy adopted as to division of expense, each project determined by agreement. Most projects on basis of 50 per cent to state and 50 per cent to railroad.

Kansas.—Federal aid is allocated to individual grade crossing projects on the basis of 50 per cent of cost, 25 per cent to county, 25 per cent to railroad.

Kentucky.—State law requires railroads to pay 50 per cent of the expense of that part of a grade separation project lying within the right-of-way lines. The state pays all of the expense for that part lying beyond these lines. Federal aid funds are absorbed in the state funds.

Louisiana.—Federal aid funds are regarded as state funds. Grade separation costs are divided 50 per cent to the state and 50 per cent to the railroad.

Maine.—No grade crossing separation project has been included in the state's federal aid road program. In accordance with an Act of 1917 the municipal officers of a town or city may file with the Public Utilities Commision a petition for grade separation. In such case, if approved, the expense is divided 25 per cent to the state, 10 per cent to the town, and 65 per cent to the railroad.

Massachusetts.—The railroad laws of Massachusetts provide for the appointment of a special commission in each case of grade crossing elimination work, whose duties shall include the apportionment of the cost among the various parties interested. The commission shall meet at once, and if it decides that the security and convenience of the public require the alterations to be made, it shall prescribe the manner and limits thereof, and shall determine which of the parties shall do the work, or shall apportion the work between each of the railroad corporations and the city or town. The railroad corporations shall pay 65 per cent of the total actual cost of the alterations including the actual cost to any street railway company of changing its railway, the cost of the hearing, the compensation of the commissioners, and auditors, and all damages except as otherwise provided. The commission may, subject to a right of appeal to the Superior Court by the street railway company or by the commonwealth for a revision by a jury of the amount of such assessment, assess upon any street railway company made a party to the proceedings such percentage of the total cost not exceeding 15 per cent as may, in the judgment of the commission, be just and equitable. The remainder of the total cost

Method of Apportioning Cost of Street and Highway Improvements Adjacent and Parallel to Railroad Rights-of-Way

STATE	General County Tax	State Bond Issue	General Township Tax	State Funds	General Bond Issues	Special District Tax	Gasoline Tax	Motor Licenses	Benefit Basis	Frontage Basis	Valuation Basis	REMARKS
Alabama	✓						✓	✓				
Arizona	✓			✓	✓		✓					Railroads not assessed
Arkansas				✓		✓	✓	✓				
California	✓	✓			✓	✓	✓	✓				
Colorado		✓		✓			✓	✓				
Connecticut				✓			✓	✓				Railroads not assessed
Delaware	✓	✓					✓	✓				Railroads in assessed - Bond retired by gasoline tax
Florida							✓	✓		✓		Assessments legal only in counties with population between 11000 and 100000
Georgia	✓						✓	✓				No special assessments
Idaho	✓		✓	✓		✓	✓	✓				Legality of district tax doubtful
Illinois		✓						✓				Bonds retired by motor licenses
Indiana						✓	✓	✓	✓			
Iowa							✓	✓				Federal aid used
Kansas	✓		✓	✓			✓	✓				Federal aid about $5000 per mile
Kentucky							✓	✓				
Louisiana	✓					✓	✓	✓				County bonds retired by advalorem tax
Maine	✓			✓			✓	✓				No special assessments
Maryland	✓	✓					✓	✓				Bonds retired by general taxes - Motor and gasoline tax used for maintenance only
Massachusetts				✓				✓				Railroad not assessed
Michigan	✓	✓					✓	✓	✓			
Minnesota	✓		✓	✓			✓	✓				
Mississippi						✓	✓	✓			✓	Property taxed on advalorem basis
Missouri		✓					✓	✓				Bonds retired by motor license fees
Montana	✓						✓	✓				
Nebraska				✓			✓	✓				
Nevada	✓	✓		✓			✓	✓				Bond issues retired by poll and gasoline tax
New Hampshire				✓			✓	✓				
New Jersey	✓			✓								No special assessment
New Mexico							✓	✓				
New York	✓	✓		✓								No special assessment
North Carolina		✓					✓	✓				Bond issues retired by motor license and gasoline tax
North Dakota			✓		✓		✓	✓				
Ohio							✓	✓	✓			
Oklahoma	✓		✓	✓	✓		✓	✓				Bonds retired by advalorem tax
Oregon	✓	✓					✓	✓				Bonds retired by motor license & gasoline tax
Pennsylvania	✓	✓	✓				✓	✓				No special assessment
Rhode Island							✓	✓				Railroads not assessed
South Carolina	✓						✓	✓				
South Dakota							✓	✓				
Tennessee	✓						✓	✓				
Texas							✓	✓				
Utah	✓				✓		✓	✓				Bonds retired by advalorem tax
Vermont							✓	✓				Railroads not assessed
Virginia							✓	✓				No special assessment
Washington						✓	✓	✓				
West Virginia		✓					✓	✓				No special assessment
Wisconsin	✓		✓		✓		✓	✓				
Wyoming						✓	✓	✓				

shall be apportioned by the commission between the commonwealth and the city or town in which the crossing is situated, and in making the apportionment the commission shall take into account the benefits to the city or town and its financial ability, and shall assess upon the city or town such percentage of the total cost, not exceeding 10 per cent, as may in its judgment be just, and in case less than 10 per cent of the total cost is assessed upon the city or town, the difference between the amounts so assessed and 10 per cent shall be assessed upon the railroad corporations in addition to the 65 per cent, or upon the commonwealth, or shall be apportioned between the railroad corporations and the commonwealth. The commission shall equitably apportion the 65 per cent and such additional sum as may be assessed, to be paid by the railroad corporation between the several railroads which may be parties to the proceedings. If the crossing was established after June 21, 1890, no part of the cost shall be charged to the commonwealth; and such part as thus becomes unapportionable shall be borne by the railroad corporation, the street railway company, if any, and the city or town, in addition to the other amounts payable by them, in such proportions as the commission shall determine.

Where a grade crossing is eliminated by agreement between the municipality and the railroad company, approved by the Department of Public Utilities, the commonwealth pays 20 per cent of the cost and the apportionment between the municipality and the company is a part of the agreement.

Maryland.—The Public Service Commission is without jurisdiction over the highways of the state, such authority being lodged in the County Commissioners.

Michigan.—Federal aid funds are considered as state money. Act 114 relating to highways and bridges provides that the state or other political subdivision will pay 50 per cent of the cost and the railroad 50 per cent.

Minnesota.—No federal aid has been applied to grade separation projects. No fixed policy as to division of expense as between the state and the railroads. Certain grade crossings considered dangerous may be designated as "Stop Crossings," and have a sign marked "Stop." The law provides as follows:

"Section 6. Whenever any vehicle carrying school children, explosives or inflammable liquids, or pasengers for hire, or any trucks or any vehicle having in tow any other vehicle or equipment, or any vehicle of the tractor or caterpillar type, approaches any grade crossing it shall be the duty of the driver thereof to bring the same to a complete stop before reaching the railroad track and before crossing said track to ascertain when such crossing can be made in safety."

Mississippi.—Grade separation projects have been paid for by federal aid 50 per cent and railroad 50 per cent; no state funds having been expended for such purposes.

Missouri.—Federal aid funds are absorbed in the state funds and very few grade separation projects have had any federal aid money applied to them. Division of expense in grade separation projects is determined by agreement.

Montana.—Due to the unappropriated public land in the state, 56 per cent of federal aid is available for grade separation projects. Such work as has been done in the state the railroads have borne 44 per cent. It is admitted that it is only fair and equitable that the state or county should assume a part of the 44 per cent, and in some instances this has been done, one-half of the 44 per cent being borne by the state or county.

Nebraska.—No provision in the state laws relating to the division of expense for a grade separation, but frequently the expense is divided 50 per cent to the railroad, 25 per cent to the state, 25 per cent federal aid.

Nevada.—The unappropriated public lands is about 87 per cent of the state area, and federal aid absorbs about 75 per cent of the cost of all federal aid

Statement of Grade Crossings Showing Kinds of Protection of Various Railroads of the United States and Canada, 1925

KIND OF PROTECTION															
		GATES			WATCHMEN			SIGNALS				SIGNS			
		With or Without other Protection			Alone or without other Protection other than Gates										
UNITED STATES RAILWAYS		Operated 24 hrs. per day	Operated less than 24 hrs per day	Total	On duty 24 hrs per day	On duty less than 24 hrs per day	Total	Both Audible and Visible Signals	Audible Signals only	Visible Signals only	Total	Special Fixed Signs or Barriers in addition to Standard Fixed Crossing Signs only	Total	Grand Total Crossings
Name of Rail Road															
A.B.&A.	Jan. 1st	—	—	—	1	5	6	—	7	—	7	—	532	532	545
	Dec. 31st	—	—	—	1	5	6	—	8	—	8	—	532	532	546
Atlantic Coast Line	Jan. 1st	27	8	35	8	53	61	23	—	—	23	—	4973	4973	5092
	Dec. 31st	27	8	35	8	53	61	23	—	—	23	—	4962	4962	5081
B.&O.	Jan. 1st	93	103	196	43	257	300	14	213	111	338	486	4347	4805	5637
	Dec. 31st	91	104	195	47	250	297	18	191	191	360	593	4189	5782	5634
Boston & Maine	Jan. 1st	151	207	358	17	213	230	140	126	—	266	—	1067	1067	1921
	Dec. 31st	148	197	345	16	185	201	166	109	—	275	—	1095	1095	1876
B.R.&P.	Jan. 1st	1	1	2	11	19	30	16	25	2	41	486	—	486	559
	Dec. 31st	1	1	2	11	20	31	14	27	5	46	485	—	485	564
C.&A.	Jan. 1st	8	33	41	3	58	61	19	92	—	111	—	971	971	1184
	Dec. 31st	8	33	41	4	58	62	28	89	—	117	—	964	964	1184
C.B.&Q.	Jan. 1st	42	151	193	38	116	151	252	106	28	386	1349	8043	9392	10122
	Dec. 31st	44	149	193	35	117	152	258	102	28	388	1357	8036	9393	10136
C.C.C.&St.L.	Jan. 1st	37	149	186	31	260	291	80	224	27	331	395	2091	2486	3294
	Dec. 31st	35	138	173	30	245	275	86	217	74	377	395	2071	2466	3291
C.&E.I.R.R.	Jan. 1st	18	34	52	9	61	70	21	36	—	57	599	601	1000	1179
	Dec. 31st	18	34	52	10	63	73	21	35	—	56	598	602	1000	1181
Central of Georgia	Jan. 1st	—	1	1	7	39	46	24	8	1	33	—	1729	1729	1809
	Dec. 31st	—	1	1	7	37	44	24	12	1	37	250	1459	1709	1791
C.I.&L.Ry.	Jan. 1st	21	4	25	3	59	62	43	28	2	73	—	634	634	797
	Dec. 31st	21	4	25	3	57	60	44	27	4	75	—	636	636	796
C.M.&St.Paul	Jan. 1st	56	113	169	20	248	268	282	201	26	449	138	9584	9722	10608
	Dec. 31st	56	113	169	19	252	271	237	198	27	462	139	9545	9684	10586
C.&O.	Jan. 1st	41	9	50	5	35	40	14	40	13	67	255	1329	1584	1741
	Dec. 31st	41	9	50	5	34	39	14	41	25	80	255	1474	1729	1888
C.&N.W.	Jan. 1st	207	169	376	42	257	299	236	173	11	420	2163	6002	8165	9260
	Dec. 31st	200	165	369	43	243	286	290	166	11	457	2216	5995	8211	9319
Colo. & Southern.	Jan. 1st	1	—	1	21	11	32	12	13	8	33	—	657	657	723
	Dec. 31st	1	2	3	—	26	26	19	9	9	33	—	721	721	783
C.R.I.&P.	Jan. 1st	30	57	87	38	213	251	134	104	16	254	244	7454	7698	8270
	Dec. 31st	30	57	87	38	213	251	139	109	16	264	246	7428	7674	8276
C.R.R. of N.J.	Jan. 1st	66	70	136	6	53	59	16	81	13	110	2	555	557	842
	Dec. 31st	63	70	133	6	53	59	13	78	21	112	2	558	560	844
C.St.P.M.&O.	Jan. 1st	1	14	15	2	36	38	13	77	6	96	395	1212	1607	1756
	Dec. 31st	1	13	14	2	37	39	22	70	11	103	395	1206	1601	1797
D.L.&W.	Jan. 1st	112	41	153	17	76	93	118	91	6	215	—	525	525	986
	Dec. 31st	107	41	148	18	70	88	125	83	7	215	—	517	517	965
Denver & Rio Grande.	Jan. 1st	—	—	—	4	25	29	33	24	—	57	—	1433	1433	1519
	Dec. 31st	—	—	—	4	25	29	32	24	—	56	—	1431	1431	1516
Gulf Colo.& Santa Fe.	Jan. 1st	2	6	8	1	21	22	41	45	—	86	—	1437	1437	1553
	Dec. 31st	2	6	8	1	20	21	53	44	—	97	33	1398	1431	1557
Hocking Valley	Jan. 1st.	1	—	1	2	9	11	3	15	—	18	9	469	478	508
	Dec. 31st	1	—	1	2	10	12	3	15	—	18	8	469	477	508
Illinois Central	Jan. 1st	62	36	98	14	163	177	157	203	26	386	590	5514	6104	6765
	Dec. 31st	62	31	93	17	159	176	191	190	28	409	600	5521	6121	6799
Lehigh Valley	Jan. 1st	61	34	95	4	37	41	88	21	16	125	—	1093	1093	1534
	Dec. 31st	59	39	98	4	34	38	78	21	19	118	—	1077	1077	1351
L.&N. Ry	Jan. 1st	43	37	80	29	94	123	266	90	—	356	3	4044	4047	4606
	Dec. 31st	44	34	78	29	94	123	322	43	—	365	3	4029	4032	4598
Long Island R.R.	Jan. 1st	184	26	210	11	39	50	10	50	1	61	—	290	290	607
	Dec. 31st	201	18	219	1	36	37	24	47	—	71	—	279	279	606
Main Central	Jan. 1st	49	43	92	7	31	38	80	9	23	112	—	648	648	890
	Dec. 31st	49	43	92	7	32	39	80	8	21	109	—	615	615	855
Mich. Central.	Jan. 1st	117	48	165	28	56	84	98	103	21	222	1036	915	1951	2424
	Dec. 31st	119	46	181	26	54	80	108	99	34	241	1029	904	1933	2415
Minneapolis & St. Paul	Jan. 1st	1	6	7	3	18	21	3	6	1	10	171	1750	1921	1959
	Dec. 31st	1	6	7	3	18	21	3	6	1	10	171	1735	1906	1944
M.K.&T.	Jan. 1st	8	5	13	2	75	77	11	143	—	154	145	3244	3389	3633
	Dec. 31st	8	5	13	2	74	76	16	143	—	159	485	2900	3385	3633
Mobile & Ohio	Jan. 1st	—	—	—	—	31	31	—	5	—	5	—	731	731	767
	Dec. 31st	—	—	—	—	27	27	—	4	—	4	—	736	736	767

highway expense. Grade crossing expense is apportioned by the Public Service Commission, same having decided in a hearing being brought against the Santa Fe that the railroad should asume 33-1/3 per cent of the cost, this being considered by the Commission as fair and equitable.

New Hampshire.—Only one grade separation has been effected at joint expense; here the railroad paid 33-1/3 per cent, federal aid and the state taking 66-2/3 per cent.

New Jersey.—While the law of March 12, 1913, requires the railroads to bear the total expense of grade separation, there have been a number of instances when counties, municipalities, and the state have assumed a portion of the expense of elimination, the railroad building the bridge structure, and the public bearing the cost of the approaches.

Federal aid is not applied on grade separation projects.

New Mexico.—No state laws with reference to grade separation, but due to the unappropriated public lands, federal aid takes 63.43 per cent of the cost, the state applies this and the railroad pays the balance.

New York.—Under a law passed in 1926, the state has a $300,000,000 bond issue for the purpose of grade separation of steam and electric railroads. It is specified that 50 per cent of the expense shall be borne by the railroads, 25 per cent by the state, 25 per cent by the town, city or village within which the crossing is located.

No consideration is given in these provisions to federal aid funds.

North Carolina.—Federal aid funds are regarded as state funds. The expense of grade separation is divided 50 per cent to the state, 50 per cent to the railroad. There is a Stop Law requiring motor vehicles to stop not less than 50 ft. from the nearest rail.

South Dakota.—Division of expense on any given grade separation project determined by Railroad Commission, usually 50 per cent to the railroad, and 50 per cent to the state. Federal aid funds being thrown into the state funds.

Ohio.—No federal aid funds have been used on highway crossings. No fixed policy adopted as to division of expense for grade separation.

Oklahoma.—Federal aid funds not applied to grade separation projects. The usual division of expense being that the state bears all expense for improvements off the railroad right-of-way and 50 per cent of those on the right-of-way. The railroad takes 50 per cent of the cost of improvements on the right-of-way. In 1925 the state legislature passed an act requiring any motor-driven vehicle to come to a complete stop before crossing any steam or electric railway track.

Oregon.—Section 4811, laws of 1917, provides: "The Commission shall have the exclusive power . . . to require . . . a separation of grades at any such crossings . . . and to prescribe the terms upon which such separation shall be made and the proportions in which the expense of alteration or abolition of such crossings or the separation of such grades shall be divided between the railroad or street railroad or street railroad corporations affected, or between such corporations and the state, county, municipality or other public authority in interest."

Pennsylvania.—Federal aid funds are given no consideration in apportioning the cost of grade separation. The division of cost is determined by the Public Service Commission, and in general it has been 50 per cent by the railroads, 25 per cent by the county, and 25 per cent by the state.

Rhode Island.—Two grade separations have been effected since 1903. Both of these were federal aid projects, the expense divided 50 per cent federal aid, 25 per cent state, and 25 per cent railroads.

South Carolina.—Act 634 of March, 1924, was passed to establish a uniform basis for elimination of grade crossings. It provides that for a highway overcrossing the railroad shall pay 50 per cent of the cost, including the approaches for a distance not exceeding 150 ft. on either side of the railroad, and the state shall pay the remaining 50 per cent. For a highway undercrossing the state shall pay 50 per cent of the cost to cut through the railroad

Statement of Grade Crossings Showing Kinds of Protection of Various Railroads of the United States and Canada, 1925, (Continued from p. 169)

KIND OF PROTECTION																
		GATES			WATCHMEN			SIGNALS				SIGNS			
		With or Without other Protection			Alone or without other Protection than Gates										
UNITED STATES RAILWAYS		Operated 24 hrs. per day	Operated less than 24 hrs per day	Total	On duty 24 hrs per day	On duty less than 24 hrs per day	Total	Both Audible and Visible Signals	Audible Signals only	Visible Signals only	Total	Special Fixed Signs or Banners in addition Standard Fixed Crossing Signs only	Total	Grand Total Crossings
Name of Rail Road															
Mo Pacific	Jan 1st	28	35	63	20	71	91	109	158	6	273	11	6132	6153	6960
	Dec 31st	24	37	61	17	66	83	130	160	6	296	30	6115	6145	6589
N.C & St.L	Jan 1st	2	4	6	8	40	48	16	—	—	16	—	1149	1149	1219
	Dec 31st	2	4	6	9	39	48	24	—	—	24	1	1143	1144	1222
Nickle Plate	Jan 1st	33	29	62	19	130	149	40	95	75	210	126	1438	1564	1981
	Dec 31st	33	29	62	16	126	142	48	95	80	223	126	1431	1557	1984
Northern Pacific *	Jan 1st	13	38	51	12	76	88	100	53	31	184	207	5011	5218	5441
	Dec 31.	12	33	45	16	72	87	110	49	32	191	209	4900	5109	5432
N & W	Jan 1st,	38	34	72	4	20	24	39	44	4	87	36	1416	1452	1655
	Dec 31st	38	34	72	4	20	24	41	44	4	89	36	1390	1426	1611
N Y C Ohio Central Lines	Jan 1st,	5	5	10	2	31	33	5	24	2	31	—	925	925	999
	Dec 31st	5	5	10	2	32	34	6	18	5	29	—	920	920	993
N.Y.C Eastern Lines	Jan 1st,	151	95	246	69	305	374	12	246	35	293	—	1869	1869	2782
	Dec 31st	148	89	237	72	293	365	18	239	57	314	—	1893	1893	2769
N.Y. N H & H	Jan 1st,	99	191	290	25	181	206	61	192	40	293	759	59	818	1967
	Dec 31st	97	186	283	21	179	200	62	153	43	258	720	48	768	1509
Penna System	Jan 1st	219	465	684	253	885	1138	140	449	286	875	—	9598	9598	12293
	Dec 31st	431	259	690	250	844	1094	101	451	248	800	651	9091	9742	12306
P.M	Jan 1st	45	16	61	4	77	81	44	102	13	159	—	2744	2744	3045
	Dec. 31st	48	16	64	6	77	83	53	93	26	172	—	2757	2757	3076
P & R	Jan. 1st	163	57	220	17	155	172	20	218	67	305	—	1311	1311	2008
	Dec 31st	163	56	219	17	155	172	19	131	160	310	—	1309	1309	2010
Seaboard Air Line	Jan 1st	22	28	50	4	40	44	—	6	1	7	—	4639	4639	4740
	Dec 31st	26	28	54	6	39	45	—	7	1	8	—	4872	4872	4979
Soo Line M St P & St M	Jan 1st	27	28	55	6	68	74	49	33	—	82	11	4116	4127	4336
	Dec 31st	27	28	55	6	68	74	51	34	—	85	11	4113	4124	4338
Southern Ry	Jan. 1st	50	34	84	36	204	240	52	69	36	157	7384	1508	8892	9373
	Dec 31st	49	32	81	35	205	240	52	69	39	160	7362	1495	8857	9338
Southern Pacific Texas & Louisiana	Jan 1st	15	24	39	2	54	56	79	20	—	99	46	3082	3128	3527
	Dec 31st	16	29	45	2	52	54	91	20	—	111	47	3942	3989	4197
Southern Pacific Pacific Lines	Jan 1st	25	52	77	32	125	157	504	294	21	819	59	5980	6039	7092
	Dec 31st	25	52	77	44	133	177	560	262	23	845	57	2695	5752	6851
St L & S F R R	Jan 1st	17	10	27	33	110	143	18	100	1	119	109	6198	6307	6596
	Dec. 31st	17	10	27	33	87	120	29	95	1	125	929	5129	6058	6330
Union Pacific	Jan 1st	9	5	14	11	56	67	85	90	2	177	21	3690	3711	3954
	Dec 31st	9	5	14	11	57	68	86	86	3	175	21	3691	3712	3969
Union Pacific Los Angles & Salt Lake	Jan 1st	13	7	20	—	7	7	120	3	—	123	—	905	905	1055
	Dec 31st	12	7	19	2	11	13	125	3	—	128	—	914	914	1074
Wabash	Jan 1st	28	72	100	16	105	121	57	115	41	213	587	2033	2620	3054
	Dec 31	28	72	100	18	105	123	62	113	43	218	638	1976	2614	3055
Western Maryland	Jan 1st	8	11	19	4	39	39	7	73	—	80	—	442	442	980
	Dec 31st	8	11	19	4	35	39	7	73	—	80	—	441	441	579
Western Pacific	Jan 1st	5	—	5	1	6	7	43	11	6	60	—	474	474	544
	Dec 31st	5	—	5	1	5	6	47	10	6	63	—	474	474	546
Total	Jan 1st	2653	2645	5098	998	5431	6429	3787	4712	1025	9524	17582	138596	156178	177229
	Dec 31st	2695	2589	5042	990	5301	6291	4163	4416	1270	9849	19878	136743	156621	177813
Percent	Dec 31st	15	13	28	6	29	35	23	25	7	55	112	77	882	
CANADIAN RAILWAYS															
Canadian National	Jan 1st	162	2	164	37	37	74	60	247	1	308	—	—	—	546
	Dec 31st	156	2	158	37	37	74	75	240	2	317	—	—	—	549
Canadian Pacific	Jan 1st	68	8	76	15	43	58	129	55	—	184	—	10509	10509	10807
	Dec 31st	68	8	76	15	42	57	137	35	—	172	—	10502	10502	10807
Total	Jan 1st	230	10	240	52	80	132	189	282	1	472	—	10509	10509	11353
	Dec 31st	224	10	234	52	79	131	212	275	2	489	—	10502	10502	11356
Grand Total U.S.& Canada	Jan 1st	2883	2655	5338	1050	5511	6561	3976	4994	1026	9996	17582	149105	166687	188582
	Dec 31st	2877	2599	5276	1042	5380	6422	4375	4691	1272	10338	19878	147245	167123	189179
Percent	Dec 31st	15	13	28	6	28	34	23	24	7	54	105	779	884	

* Note. 409 Crossing not protected Jan 1st 1925 and 415 Dec 31st 1925 not listed above

fill, and of the cost of the bridge carrying the railroad, including the foundations and piers or abutments for such bridge, but the cost of the approaches to such underpass shall be paid by the state. Drainage costs shall be borne by the state. Federal aid is absorbed in the state funds.

South Dakota.—Federal aid funds are not used in crossing eliminations. The law of 1919 provides in general that the cost of grade separation upon the railroad right-of-way shall be borne by the railroad, and the approaches by the state. Additional right-of-way, if required, shall be paid for by the state.

Tennessee.—Under an act passed and approved April 9, 1921, the State Highway Commission shall have the power to eliminate grade crossings of any railroad or interurban railway track on any of the main traveled roads now or hereafter designated by the State Highway Commission as included in the general highway plan of the state. The act provides that the expense incurred by the railroad for surveys and plans for a grade separation project shall be paid one-half by the state and in case a crossing separation is ordered and subsequently revoked the state shall reimburse the railroad for all expense incurred for surveys and preparation of plans.

It is further provided that the total cost of a grade crossing separation shall be borne 50 per cent by the railroad and 50 per cent out of the public funds as a part of the cost of the highway of which the crossing is a part; this provision to apply only to crossings already in existence or hereafter made or proposed over railroad tracks in existence at the date of the order, for elimination thereof, and shall not apply to any crossing of any highway by any railroad not in existence at the date of the designation of such highway a part of the state system. There is also a provision for the division of cost of maintenance, the railroad to maintain that part on its right-of-way, except the surface of the highway which the Highway Commission shall maintain, a plank floor of an overgrade crossing being excepted as being a part of the bridge.

Texas.—The apportionment of federal aid to grade separation projects is not uniform. In some instances there is allotted 50 per cent federal aid, 25 per cent state, 25 per cent county. Others 50 per cent federal aid, 25 per cent state, 25 per cent railroad. Still others 50 per cent state, 50 per cent railroad.

Utah.—A definite policy of apportioning grade separation expense has not been adopted. The division of expense may be determined by the Public Utilities Commission and in a number of instances have been done so on the basis of federal aid 35 per cent, county 15 per cent, railroad 50 per cent.

Vermont.—Federal aid funds are taken into the general state fund. Grade elimination may be ordered by the Public Service Commission, the state paying 35 per cent of the cost, the railroad 65 per cent.

Virginia.—Federal aid funds are absorbed in the state funds. County boards, or city or town authorities, may petition a railroad company for the separation of grades. If the work is not started in 60 days, they may appeal to the State Corporation Commission, which after hearing will make a decision and in case of disagreement may prescribe the character of the work.

That part of Section 3974 of the 1919 Code, relating to the distribution of expense, provides as follows:

"When such improvement is to be made in any railroad it shall be made by the corporation operating the same, and the whole expense thereof shall be paid by such corporation. When it is to be made in a county road, street or other highway, it shall be made by the corporation whose track is to be crossed and the expense shall be borne equally by said corporation and by the county, city or town having control of such county road, street or other highway. Provided that whenever an existing crossing of a highway by a railroad or of a railroad by a highway, at grade, constructed since June 13, 1904, or hereafter constructed becomes, in the opinion of the board of supervisors of any county or the proper authorities of a city or town, a menace to the public safety, or the elimination of such crossing becomes necessary for the improvement of the highway, and the costs thereof, and by whom and in what proportion paid cannot be agreed on, the same shall be fixed and determined by the State Corporation Commission in conformity with the principles of law and equity.

"After said crosing has been constructed, the corporation whose track or work is crossed shall maintain the same."

In 1922 a law was passed requiring all vehicles to come to a full stop at grade crossings of main line railroads not nearer than 10 ft. and not further than 50 ft. from the track.

Washington.—Federal aid funds are absorbed in the state funds. In grade crossing elimination the state may assume not more than 10 per cent of the cost, the railroad paying the balance. Municipal authorities have jurisdiction within city limits.

West Virginia.—Federal aid funds are made a part of the state funds. For a grade separation project the state shall bear 50 per cent of the cost, including that for preparing plans, specifications, estimates and securing bids; the railroad shall pay the remaining 50 per cent.

Wisconsin.—Federal aid funds are absorbed in the state funds. The division of expense for grade crossing elimination on a road to be improved is on the following basis: First the cost of improving the present road is determined, then the excess cost of the grade separation over the improvement of existing road is apportioned 60 per cent to the state, and 40 per cent to the railroad.

Wyoming.—Federal aid funds are absorbed in the state funds. Expenditures for grade separation are divided 50 per cent to the state and 50 per cent to the railroad.

Canada.—The Railway Act of Canada in 1919 provided that the Board of Railway Commissioners should have jurisdiction over railways and their relations with public highways. No change is reported to have been made in the provisions of the law as quoted on page 649 of the 1924 Proceedings.

Grade Crossing Protection.—The information obtained by the committee and reported at the convention shows that the kinds of protection generally used are as follows: (1) Gates with or without other protection, operated 24 hours per day; (2) gates with or without other protection, operated less than 24 hours per day; (3) watchmen alone or with protection other than gates on duty 24 hours per day; (4) watchmen alone or with protection other than gates on duty less than 24 hours per day; (5) both audible and visible protection without either protection; (6) audible signals only; (7) visible signals only; (8) special fixed signs, or barriers, in addition to standard fixed signs; (9) standard fixed signs only.

Gates.—Of the total number of crossings reported, 2.8 per cent were projected by gates, 2,877 being in service 24 hours and 2,399 in service less than 24 hours. There were 62 less crossings protected by gates on December 31, 1925, than there was on January 1 of that year. This type of protection is good under certain conditions where street traffic is not too heavy and when operated for 24 hours, but it also has its disadvantages.

Watchmen.—Three and four-tenths per cent of the crossings reported are protected by crossing watchmen, or a total of 6,422 crossings; 990 of these are protected during the 24 hours and 5,380 less than 24 hours per day. There were 139 less crossings protected by watchmen on December 31, 1925, than on January 1, 1925, showing that this type of protection is decreasing. With the advent of the automobile traffic, conditions have changed and a crossing watchman must be alert, physically and mentally. Where considerable switching is done crossing watchmen probably afford the best protection, but on the average crossing we do not believe this is the best type of protection. Where crossing watchmen are used they should display a "Stop" disc by day and a red hooded lantern by light, when it is unsafe to cross. Crossing watchmen should have police power of control over traffic.

Signals.—Five and four-tenths per cent of the crossings reported are protected by signals, or a total of 10,238 crossings, 4,367 of the crossings being protected by both audible and visible signals, 4,691 by audible signals only,

and 1,272 by visible signals only. During 1925 there was an increase of 391 crossings protected by both audible and visible signals, a decrease of 303 crossings protected by audible signals only and an increase of 246 crossings protected by visible signals only.

The committee suggested that where practicable, the automatic visible signal is the most efficient protection in use for the following reasons: (1) It is automatic; (2) the failure of the engineman to blow the whistle or ring the bell has no effect on the signal; (3) weather conditions have no material effect on it; (4) signals are easily seen and there is no mistaking the signal given.

Special Fixed Signs or Barriers.—This applies to advance signs placed on side of the roadway calling attention to the approach to railroad crossings. The special fixed sign in advance of the standard crossing sign is an excellent thing, as it gives the user of the highway advance notice that he is approaching a railroad crossing, according to the committee.

Standard Fixed Crossing Signs.—By far the greater number of crossings are protected in this manner only, being 77.9 per cent or 147,245 crossings as of December 31, 1925. It would seem that the crossing protected only by standard fixed signs, being so universal, is the one which should be given serious consideration.

Safety Rules.—The railroads should see: (1) That all obstructions on the right-of-way are removed so as to give as clear a view as possible of the tracks; (2) that the crossings and grades are kept in the best possible condition; (3) the enginemen blow their whistle and ring engine bell on approaching crossings and continue until crossing is reached; (4) that engine be equipped with whistle of sufficient volume to be heard at the crossing, and (5) that cars, so far as possible, are not left standing on tracks adjacent to crossing where they will obstruct the view.

The public should: Approach crossings cautiously and not attempt to cross until they have satisfied themselves that no trains are approaching. They must realize that trains must travel on the rails and that they must maintain their speed in order to make schedule, required by the public.

The public authorities should see: (1) That all obstructions off of the right-of-way are removed so as to give as clear a view as possible of the tracks, and (2) that grades approaching crossings are kept in good condition.

Federal Aid Laws.—In reporting on a study made of laws and regulations affecting the apportionment of federal aid, and of the proper form and character of division of costs of separation of grades between the railway, state, county, municipal or other corporation, the committee included within its report a list of the congressional acts under which federal aid is authorized. In order to inform itself as to the legal status of the federal aid acts, the committee addressed an inquiry to the legal departments of various railroads. The matter was referred to the Western Conference of Railway Counsel and its reply indicates: (1) There is no specific provision in the federal statutes requiring the states to apportion any part of the state quota of funds secured from federal aid to grade separation projects; (2) there is no provision in any of the federal aid acts which railway companies can use to compel, through legal proceedings, the state to apportion a part of the federal aid allotment to a particular grade separation project; (3) there is no provision in the federal aid acts that would prohibit a state from allocating a part of its federal aid allotment to a particular grade separation project, and in fact such allocation is made in many instances.

The committee also reported that during the year a recanvass was made of the public service commissions of the states to ascertain the provisions of the laws of the several states and Canada as they apply to public crossings and, more particularly, to their application to the elimination of grade crossings.

The replies indicated that the changes in the statutes, as they appeared in the 1924 proceedings, did not warrant a restatement of them.

In handling the second part of these subjects the committee stated that it appears that the present tendency of the state authorities is to assess 50 per cent of the expense of grade separation against the railroads. It was the belief of the committee that this ratio is too high, and that the total cost to the railroads is too great for their capacity to pay, and, furthermore, that an assessment of a smaller ratio against the railroads and a corresponding increase in the proportion assumed by the public is reasonable and fair to all parties and interests.

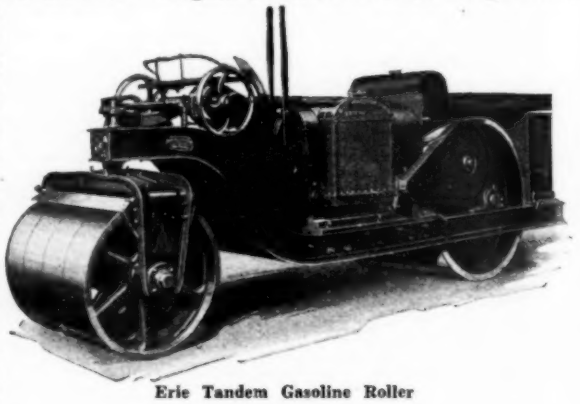
The committee concluded that the question of federal aid with reference to grade separation is at present in such shape that the state authorities can so handle the matter as to entirely eliminate the railroads from any participation in the benefits of its use and that this situation can be remedied only by legislation or possibly by changes in the regulations promulgated by the federal authorities governing the matter.

State Aid for County Highways in New York.—The New York state legislature has appropriated $2,380,000 as state aid to counties for highway construction.

New Gasoline Roller

The Erie Machine Shops, Erie, Pa., which has been manufacturing steam rollers for almost 40 years under the continuous leadership of its proprietor, P. W. Diethy, Sr., is now producing in two sizes a tandem roller powered with gasoline units.

The features of the steam type roller that have been retained in the gasoline type roller are the instant reversing, the distribution of weight, the roller and ball bearings carrying all moving parts, solid construction with high grade materials, lowness in the extreme heighth of the roller and the high clearance for rolling close to the curb and over the curb if the curb is not over 15 in. in heighth.



Erie Tandem Gasoline Roller

The equipment includes Waukesha Motors, Twin Disc heavy Duty clutches with one pin adjustments, Hyatt, Timken and S K F bearings, and Modine radiators. All drive gears are accurately cut, hardened and ground.

The power unit is mounted on a solid cast iron base which insures rigidness throughout as well as accuracy of all parts.

Research on Subgrade Soils

On Nov. 1, 1926, the U. S. Bureau of Public Roads entered into a cooperative research agreement with the Massachusetts Institute of Technology which has for its general purpose the securing and development of facts and information which may advance the science of highway engineering in regard to subgrades. The immediate purpose of the agreement is to study the influence of accidental factors upon the results of the standard tests for subgrade soils and to investigate the possibilities for improving the existing testing methods. The work of the Institute will be confined entirely to the laboratory aspects of the subgrade problem.

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148 Miles of Paving Laid Last Year at Detroit.—Detroit, in 1926, far exceeded all its previous records for paving, with 148 miles laid during the year, according to figures announced by John W. Reid, Commissioner of Public Works.

Graphic Charts in Bridge Designing

Useful Aids to the Designer Described in California Highways

By HARVEY D. STOVER
Office Engineer, Bridge Department, California State Highway Department

In the design and preparation of plans for bridges where speed and accuracy are required, graphical representation of a series of calculations very often proves of great value. Particularly so, in a case where practically the same problem occurs many times with the fundamental condition of the problem changed but slightly. Also, where use is made of a series of empirical formula, a graph will plainly show any erroneous assumptions or prevent errors which may occur in independent calculations. It is necessary to note, however, that, due to changes in specifications for unit stresses and live loads used in design, it is necessary to occasionally revise any chart or graph to keep it up to date.

The accompanying chart No. 1 has been prepared for reinforced concrete slab design with reinforcing at right angles to the direction of traffic, and chart No. 2 has been prepared for reinforced concrete slab design with reinforcing parallel to the direction of traffic.

Chart No. 1.—As a starting point in making clear the use and meaning of the charts, let us first consider chart No. 1. Take for instance, any distribution formula for a concentrated load as applied to slab design; by solving this formula for any given concentration, the distribution width in feet for various slab spans can be obtained. To consider, then, that part of the load to be carried on 1-ft. width of slab, it is but another step to obtain the maximum moment that this load would produce for various spans. By plotting the span length in feet on the abscissa and the moments in foot-pounds on the ordinate, a resulting graph can be made (curve No. 1) which will give the maximum moment on a section of slab 1 ft. wide for the various spans under consideration. The impact due to the concentrated or live load will be the required percentage of the live load, and by adding this percentage to curve No. 1, we get a curve representing live load and impact, which is noted on the chart as curve No. 3. Curve No. 2 is used only for simple spans and, therefore, is not often used in slab design. From the calculated weights of slabs that have been designed for various spans, the corresponding dead load moment is shown on curve No. 4. The addition of the ordinata of curve No. 4 to those of curve No. 3 gives the resulting curve No. 5, for use in design.

Since, for any given moment, a slab of 1-ft. width would have but one economic depth for a given fiber stress of concrete, by plotting as ordinates the effective required depth of slab in inches and establishing a new abscissa showing area of steel in square inches, another curve can be obtained showing effective depth of slabs for foot of width with concrete fiber stress of 650 or 750 lb. per square inch as required.

Typical Example of Use.—By laying off a known ordinate (steel ordinate) showing spacing of steel bars, a curve can be drawn for the various sizes of steel bars that are used in common practice. To make certain that the method of using the chart is clear, let us consider, for example, having already found by preliminary studies that the most desirable structure to provide a 30-ft. roadway for a given location would be a 3-girder concrete bridge and that the clear span between girders (slab span) is 7 ft. 4 in., the necessary steps in designing the slab would be to locate 7 ft. 4 in. on the span abscissa.

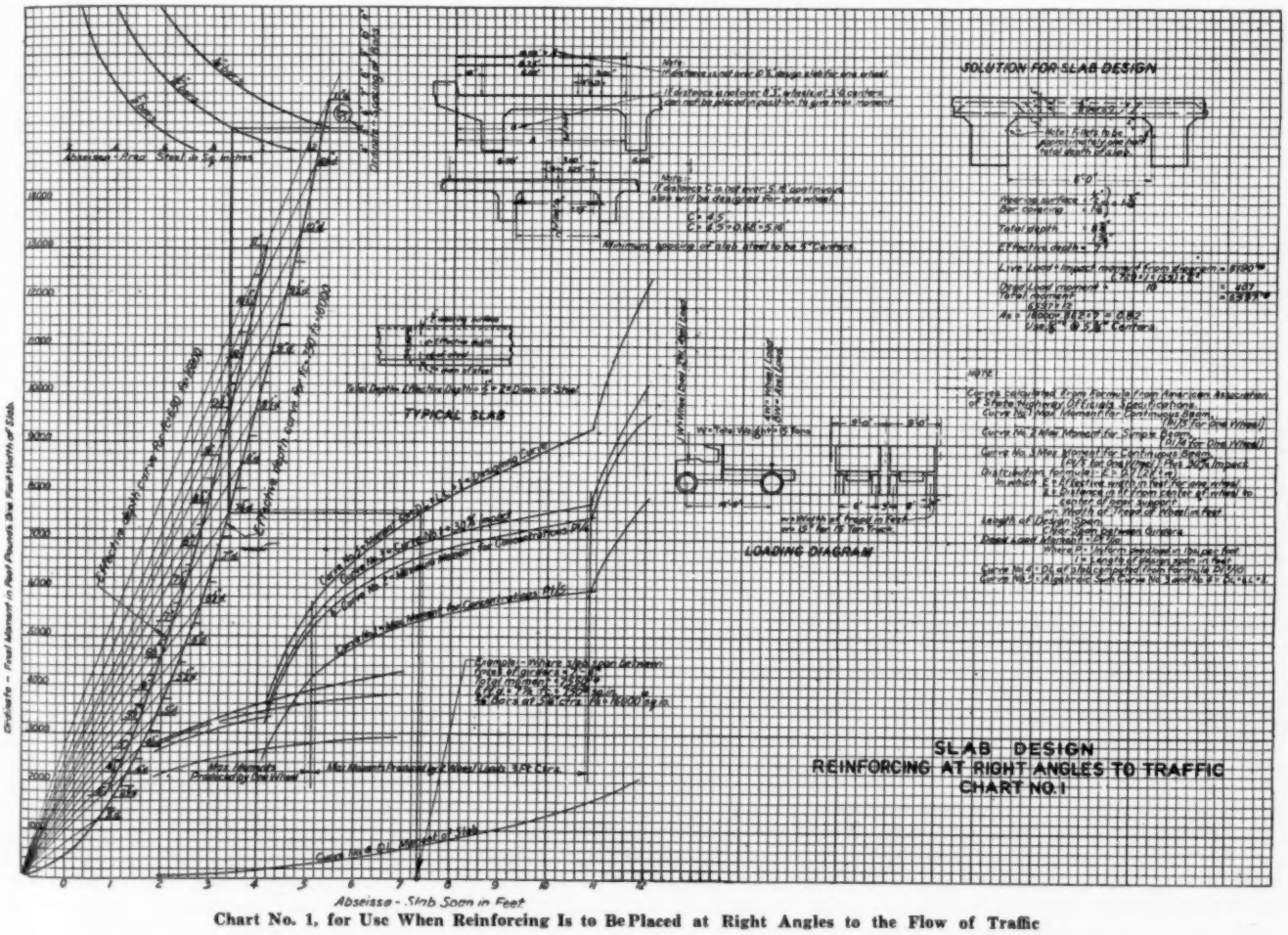

Chart No. 1, for Use When Reinforcing Is to Be Placed at Right Angles to the Flow of Traffic

The moment shown on the design curve (No. 5) is approximately 7,500 foot-pounds. By following this on a horizontal line to the effective depth curve, the required effective depth is found to be 7½ in.; from this point going vertically to the steel curve, we would have half-inch bars at 3½ in. centers, which would be too close a spacing for practical use. Therefore, we would use ⅝ in. bars at a spacing of 5½ in. centers.

Chart No. 2.—Chart No. 2 for the design of slabs where the steel is placed parallel to the direction of traffic is similar to chart No. 1 and its use will be self-explanatory.

These charts have proved of great value in checking plans as well as in the preparation of new plans. Similar charts also have been provided for use in designing simple girders and T-girders as used in reinforced concrete bridge design. They save time and make for greater accuracy in the work of the bridge department.

Ruling Made on Texas Highway Money.—The Texas Highway Commission is permitted to pay for a special audit of its status out of the "extra labor" fund, according to a ruling made last month by the Attorney General of the State.

1,000-Ft. Concrete Bridge to Be Tested to Destruction

An unusual opportunity to test to destruction a large concrete bridge of modern design has been presented in North Carolina. A dam is now under construction on the Yadkin River which will cause the impounded water to entirely submerge the bridge across the river between Albemarle and Mount Gilead.

This bridge was built by the State in 1922 as a Federal-aid project and consists of three open-spandrel arch spans of about 150 ft. each and 14 T-beam or deck-girder spans of approximately 40 ft. each. The over-all length from face to face of the ends bents is 1,069 ft.

A cooperative agreement has been entered into between the North Carolina State Highway Commission and the Bureau of Public Roads for the making of as complete tests as possible before the bridge is submerged. It is believed that the results may be of great value to the engineering profession and in order to secure the best technical direction possible several organizations have been invited to appoint a representative on an advisory committee to take charge of the direction of the tests. An invitation has been extended to the following organizations:

University of North Carolina.
North Carolina State College.
American Association of State Highway Officials.
American Society of Civil Engineers.
American Railway Engineering Association.
American Concrete Institute.
Highway Research Board.
Bureau of Standards.
American Society for Testing Materials.

At the present time all but two of these organizations have accepted the invitation. It is proposed that the advisory committee will formulate the test program and assume direction of the work from the technical standpoint. The program will be financed and carried out by the North Carolina Highway Commission and the Bureau of Public Roads.

The period during which the loading tests may be carried on will be limited to the interval between the time when it will be possible to close the bridge to traffic and the time when the bridge will be submerged by the water impounded by the dam. With this time limitation in view it will be necessary to make very complete preliminary arrangements for the work.

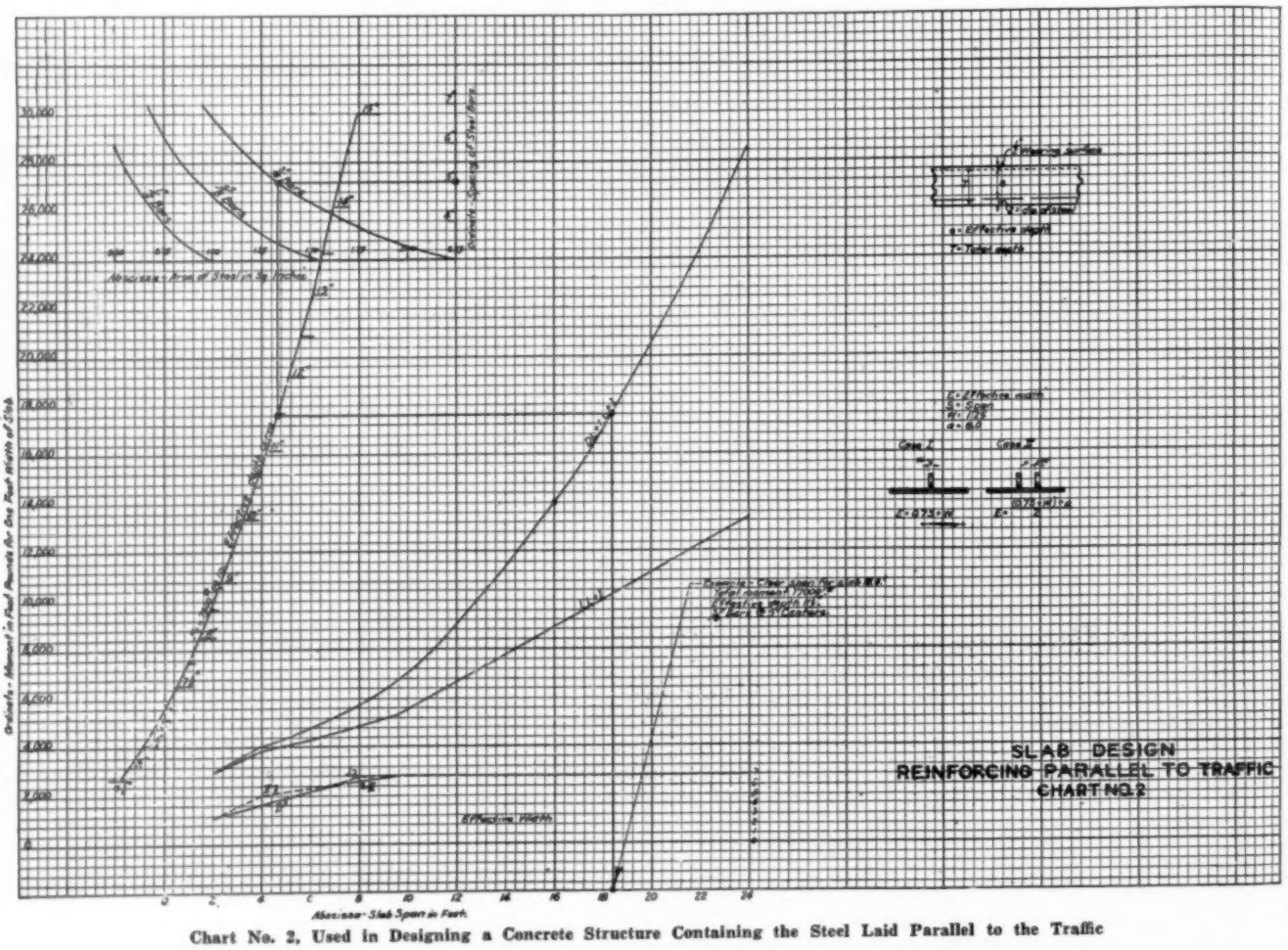

Chart No. 2, Used in Designing a Concrete Structure Containing the Steel Laid Parallel to the Traffic

Comments on Concrete Road Construction

Recent Developments in the Art of Building Concrete Pavement Summarized in Paper Presented Feb. 15 at 13th Annual Conference on Highway Engineering at University of Michigan

By A. N. JOHNSON
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Concrete road construction, as we know it today, is a very recent development. There are, however, a few scattered instances of the use of concrete in road construction extending back nearly a century. The first was the construction of about one-quarter of a mile of road outside of London on Highgate Archway Road, where a concrete base was laid in 1828 over which macadam was placed. The next use of concrete noted was for the foundation of an asphalt pavement laid in Paris about 1858. Concrete was first used as the wearing surface of a pavement in Scotland in 1865, and the following year another section was also laid in Scotland.

Early Construction of Concrete Pavements.—The method of construction of these latter roads is of interest. Concrete was laid in layers of 3 or 4 in., which was rolled and allowed to remain for three days before a second layer was placed. It was recommended that the road should be left for three weeks before opening to traffic, although the engineer reported a week was found to be a sufficient interval.

It is stated that concrete was first used in America as a base for paving in 1888 in New York. A concrete pavement with concrete wearing surface was first built in Wichita, Kan., but was not a success. The next concrete pavement of which we have record was laid in Bellefonte, O., in 1892. Between 1896 and 1906 a number of concrete streets were laid in Richmond, Ind.

But the use of concrete for highways may well be said to begin with the concrete road laid on Woodward Ave. in 1909 by the Highway Commission of Wayne County, Michigan. By 1912 a number of sections of highways had been built in Milwaukee County, Wisconsin; Cook County, Illinois, and some other points in the middle west, as well as in Wayne County.

From this date, the use of concrete for rural highways has developed very rapidly. For a somewhat more extended description of the earlier use and development of concrete highways, reference may be made to a paper by the speaker in the Proceedings of the American Concrete Institute, Vol. 20, 1924.

Application of Highway Research to Subgrade and Concrete Slab Construction.—The development of concrete roads has been greatly stimulated by research of a high degree of scientific attainment. The highway researches that have come about through concrete road construction have been especially marked. These have been carried on by many agencies, in particular the U. S. Bureau of Public Roads and the various state highway commissions, as well as by many universities.

One of these investigations to attract our attention is the series of experiments made by the Illinois Highway Department known as the Bates Road tests. A full description of the details of these tests and the results have been very ably presented before the American Society of Civil Engineers by Clifford Older, at that time Chief Engineer of the Illinois Highway Commission. His paper was presented January 17, 1924, and appears in full in the Transactions of the Society for 1924, page 1180. This series of tests consists essentially of many types of construction, extending over a distance of two miles, upon which trucks were driven with increasing loads until all of the weaker sections were destroyed. Apparatus for making measurements of the deformation of the concrete road slabs under various conditions of loading were devised, and in general, the results obtained confirm the fact previously ascertained by laboratory experiments as to the elastic properties of concrete to which further mention will be made.

We are concerned here not so much with the descriptive detail of these tests as with the results insofar as they may be usefully applied by the engineer in the construction of concrete roads. Perhaps, one of the most significant facts brought out is the behavior of clay subgrades through attempts to control the moisture content, for it is well known that the bearing power of clay soils varies with the moisture content, the greater this moisture content the less the bearing power.

It has been a practice by many engineers in preparing a subgrade through clay soils to resort to expensive side ditches and under-drains in order to reduce the moisture content of the soils. But the result of the careful observations and experiments made, as reported by Mr. Older, indicate these are of very doubtful value.

The report discusses in detail that along a 200-ft. section a 24-in. drain tile was laid below the subgrade in a trench backfilled with cinders. No difference in the moisture content was noted for a period of three years between the soil of this section and a nearby section not provided with such drains.

There is further described a similar experience on another road with different character of clay soil, where tile drains were laid 42 in. under each edge of the pavement for a distance of 1,000 ft. These trenches were also backfilled with cinders.

The results here obtained show that the section provided with tile drain contained actually more moisture, throughout a period of over a year, than under the adjacent undrained pavement. Mr. Older concludes that "to judge from these two examples in which tile drains were of absolutely no apparent value, it is questionable whether such attempts to control the moisture are of any merit whatever in clay soils."

As a result of further observations on the moisture content of the clay subgrade underlying the Bates Test Road, it was found that the moisture content of the subgrade at the time of construction was evidently an important factor in the amount of moisture that may be found in such subgrades, at least for a period of a year or more after the pavement is laid.

For example, on a section of the road laid in a rainless period in hot weather, which preceded the construction, it was found that during the following October it reached nearly a point of saturation, whereas another section laid at the time of the subgrade contained about 25 per cent of moisture did not, throughout the winter following, show any increase in the amount of moisture in the subgrade.

Mr. Older ascribes this result to the fact that if during the summer the moisture content was normal, the clays resisted further saturation; on the other hand, if they were extremely dry when the soil crumbled readily, subsequent absorption to the point of saturation takes place very rapidly. These observations suggest the desirability of thoroughly wetting a very dry clay subgrade upon laying concrete.

The extensive investigations carried on by the U. S. Bureau of Public Roads are in part reported in the Transactions of the American Society of Civil Engineers for 1925, page 264, in an article by A. T. Goldbeck describing in detail the results of numerous subgrade studies. These confirm many of the conclusions arrived at by Older. From these latter investigations, perhaps the most important conclusion to be drawn by the highway builder is that one of the most effective protections against soft clay subgrade is a layer of sandy or gravelly soil (or similar granular

material) which has a very low capillarity. This form of construction in particular gives protection against frost action.

Another important result as the outcome of the Bates Road Test was the adoption of a cross section with a thickened edge, using actually a smaller amount of concrete per mile, yet producing a road slab which showed greater resistance to heave traffic than the usual cross section thickened at the center. The conclusions in this particular from the Bates Road Test were so obvious that within one or two years from the date of the publication of the results, this cross section had been adopted by thirty-nine states. This section designed by Mr. Older is one with an edge thickness of 9 in., tapering to 5 or 6 in. 2 ft. from the outer edge, the remainder of the slab having a uniform thickness of 5 or 6 in. It was noted that at the end of the traffic test this section remained in excellent condition, and that no damage had occurred which would cause additional maintenance cost.

Effect of Steel Reinforcement in Concrete Roads.—There is, perhaps no point in connection with the construction of concrete roads about which there has been more speculation than as to the effect of steel reinforcement. Many experimental sections of roads reinforced in various ways have been constructed, as well as extensive stretches of road in which steel reinforcement of various kinds have been employed. There were, however, at hand no comprehensive digests of the results until such a study had been undertaken by the Highway Research Board in 1925, when, through the cooperation of the manufacturers of steel reinforcement, there were made possible sufficient funds to carry on a special investigation, which was done and a report made. This report forms part 2 of the Proceedings of the Fifth Annual Meeting of the Highway Research Board, December, 1925.

An examination of this report is necessary before adequate idea may be had of its extent. These comments are but fragmentary, and made for the purpose only of exciting sufficient interest for you to examine, at first hand, the report itself.

A few of the conclusions drawn, ably supported by adequate data, are presented in the report as a summary of conclusions, and are repeated here. From them many useful suggestions of practical value to the highway engineer will be found.

"1. The amount of creaking and subsequent disintegrating is a function of time; thus, the rate of cracking is a measure of the life of the pavement.

"2. The data show that steel reinforcement reduced the rate of cracking and thus increased the life of the pavement. This applies to both concrete pavements and other pavement laid upon a concrete base.

"3. Crack reduction is more economically accomplished by the use of steel reinforcement than by additional thickness of concrete.

"4. A greater reduction was afforded by small steel members closely spaced than by larger members wider spaced.

"5. Increasing weight of mesh from 25 to 56 lb. per 100 sq. ft. considerably reduced cracking.

"6. Mesh reinforcement, 25 to 56 lb. per 100 sq. ft., reduced cracks 35 to 70 per cent in pavements of like thickness.

"7. Mesh reinforcement, 25 to 56 lb. per 100 sq. ft. and bar mat reinforcement 64 lb. per 100 sq. ft.—25 per cent longitudinal—reduced cracks more than one additional inch of concrete; but one additional inch of concrete reduced cracks more than bars (42 to 48 lb. per 100 sq. ft.) placed transversely only.

"8. With good crushed stone aggregate, 56 to 90 lb. per 100 sq. ft., mesh reinforcement, or 170 lb. per 100 sq. ft. bar reinforcement, 50 per cent each way, caused a reduction in combined transverse and longitudinal cracks equal to that indicated for 2 in. additional center thickness.

"9. Mesh reinforcement of 38 lb. per 100 sq. ft. has been effective for a thin layer of concrete laid as resurfacing upon an old concrete road.

"10. One additional inch of edge thickness reduced corner cracks more than mesh reinforcement 25 to 56 lb. per 100 sq. ft. or 3/8 to 3/4 in. bar reinforcement; but progressive destruction following the appearance or corner cracks was arrested by steel reinforcement.

"11. All types of steel reinforcement across cracks tended to hold together fractured slabs.

"12. Bar reinforcement across transverse joint, without proper provision for slippage and clearance, resulted in breakage and subsequent expensive repairs.

"13. For long slabs, 75 to 100 ft. or over, edge bar reinforcement with continuous bond caused corner cracks in the area of steel exceed 1/4 sq. in.

"14. A remarkable agreement was found to exist between results of observation of roads in service and results furnished by a wide range of experimental roads and laboratory tests."

Effect on Strength of Concrete Hauled From Central Mixing Plant.—It is frequently convenient to have a central mixing plant and haul the concrete ready mixed to the job. For example, it is often necessary to widen an existing road, which may be done effectively by the construction of concrete shoulders on each side. If a mixer were on such a job it would interfere much more with the maintenance of traffic than if no mixer were required. Particularly have central mixing plants been found useful in city pavement construction. The results of the tests of the cores drilled from concrete that was hauled varying distances is, therefore, of particular interest.

Under the charge of the State Roads Commission of Maryland a central mixing plant was set up at Muirkirk on the Baltimore-Washington Road to furnish the concrete for shoulders which extended four miles on each side of the road. Cores were drilled from these shoulders a year later and tested at the laboratory of the University of Maryland. These cores were drilled on each side of the road at one-quarter mile intervals, three cores being taken at each point. The results of the crushing strength of these cores showed a steady increase in strength as the distance hauled increased up to three miles, the average increase being from 3,000 lb. to a little over 4,000 lb.; the subsequent distance up to four miles showed a slight drop from the maximum, but gave strength tests decidedly greater than for the concrete that had not been hauled.

The conclusions reached from these results are that at least up to four miles haul the concrete did not suffer any decrease in strength, but rather showed an increase, and that so far as the strength of the concrete was concerned, four-mile hauls may be safely made. Thus it is a matter solely of practical and economical handling of the work whether the concrete would be hauled as great a distance as four miles.

Development of Curing Methods.—Some attention has been paid recently to methods for curing, other than by application of wet earth to cover the roads, or by ponding. Due to the many instances where, because of dry weather or remoteness of a sufficient supply of water, a practical method to cure a concrete road surface without use of water has become increasingly important.

The use of calcium chloride sprinkled upon the surface of the road has been tried. The admixture of calcium chloride in the concrete, also the surface treatment of the newly laid road with silicate of soda solution are still other methods. The latter particularly gives considerable promise of being effective and reasonably economical. A test was made during the summer and fall of 1926 by the State Roads Commission of Maryland in cooperation with the University of Maryland and the U. S. Bureau of Public Roads, using three methods of curing. The first method was to cover the concrete with moist earth in the customary manner; second, a surface treatment of silicate of soda diluted with 25 per cent water; third, an admixture to the concrete of sodium chloride, 100 lb. being dissolved in 42 gal. of water, which made approximately 50 gal. of the solution. Two quarts of this solution were added to the concrete for every bag of cement.

As the result of crushing strength tests of 30 and 90-day cores drilled

from sections of the road cured in these various ways, it was noted that the surface treatment of silicate of soda gave somewhat greater crushing strengths than either of the other methods, thus indicating that concrete cured with the silicate of soda gave as good or better concrete than was produced by the other methods of curing. Whether the damp earth method or the silicate of soda method would be used in a given case would probably rest upon the relative cost.

Major H. D. Williar, Assistant Chief Engineer of the State Roads Commission of Maryland, reports that the earth road curing averaged 4.3 ct. per square yard, the admixture of sodium chloride 5.1 ct. and the silicate of soda a little over 3 ct. It was further noted by Major Williar that about 15 per cent of the road cured with the earth covering was somewhat cheapened because of the fact that due to cooler weather it was not necessary to cover it.

In connection with these tests, it is proper to note that there is a marked difference in the crushing strength of samples of concrete taken with cores drills, and cylinders of concrete cast in molds, even though the latter are filled with concrete from the same batch that goes into the road slab. Thus while the cylinders showed a breaking strength of perhaps 2,000 lb., the cores would indicate in the neighborhood of 3,000 lb. per square inch crushing strength.

This is of interest in connection with the fact that recently in the city of Duluth 14 blocks of concrete pavement, which it was decided to open to traffic as early as possible, were constructed of an especially rich mixture, 1:1½:2½, and the street opened to traffic as soon as cylinder molds from the concrete as placed in the street reached a strength of 2,000 lb. per square inch, which I am informed was within four days. There is every reason to suppose that had cores been drilled from this pavement, the crushing strength would have been found to be considerably greater than that recorded for the molded cylinders.

Improvement in Methods of Finishing Concrete Roads.—The hand finishing method by wooden trowels which was used in the building of earlier concrete roads left much to be desired as to quality of road surfaces. Striking templets, used with rollers and belts, were a great improvement over the hand finishing method, and led up to the development of road finishing machines. The machines most generally in use had a combined striking and tamping effect. But it was found that the result of the tamping action was to flush to the surface a layer of mortar which subsequently would scale in spots. To remedy this, these machines have been modified so as to eliminate the tamping effect, and in its place produce more nearly the result that is obtained by pushing over the surface a very heavy screed compressing the surface by squeezing it rather than by tamping. In fact, a concrete road surface that is finished by a heavy screed worked by hand, as was common in the early practice in Delaware and much used in the concrete roads in North Carolina, produces a very satisfactory surface.

Shoulder Construction.—One of the most important features in construction and maintenance of concrete roads is the shoulders.

It is generally agreed that the practice of stopping vehicles on the traveled way proper, especially of a two-lane road, causes great inconvenience to other travelers, and adds a very serious element of danger, both of which increase very rapidly with increase in the relative amount of traffic.

It has been proposed that a traffic regulation should provide that for no reason whatsoever shall a vehicle be allowed to stand within 10 to 11 ft. of the center line of the traveled way. If such a regulation is to be practicable, it would be necessary to construct shoulders of sufficient width (5 or 6 ft.) for a vehicle to stand upon. The shoulders when adjacent to a two-lane width of not less than 18 ft. would not be expected to carry traffic, nor need there be constructed for this purpose, unless upon long grades exceeding 4 to 5 per cent, other than good sod shoulders, for when such shoulders are established they resist erosion remarkably well.

On steep grades in cuts, it will be necessary to modify the shoulder width. One of the best methods of construction under such circumstances is to carry the concrete for 10 or 12 in. upon the slope, thus having the pavement itself form a gutter, the total available width being not less than 24 ft. This would permit a vehicle in an emergency to be parked at the side of the road, and still leave reasonable space for two lines of moving vehicles.

Core Drill Tests.—It has been the practice in the past few years in a number of states for the state highway commission to take samples from concrete roads by drilling cores. Special core drilling apparatus has been used for this purpose, consisting essentially of a soft steel bit, the cutting being effected by small hardened steel shot. These core samples make it possible to examine the texture of the concrete, check the thickness, and obtain the crushing strength which affords some measure of the relative value of the different concretes.

The State Roads Commission of Maryland has taken several thousand core drill samples, this work being placed immediately under the charge of the Engineering College of the University of Maryland. An examination of the results has led to one very pertinent point. For example, a number of cores close by one another, presumably from the same mix of concrete, should theoretically give the same crushing strength. Practically, this is not the case. If we take the mean of value of such a group and determine the percentage of variation of each individual of such a group from the mean value, we get values ranging from zero to perhaps 30 or 40 per cent. Such values were obtained for upwards of 1,600 cores, and it was found that the mean variation from these group means was about 8 per cent. An examination of crushing strengths of 6,000 concrete cylinders made in the laboratory under strictly controlled conditions showed a mean variation almost identical with that found for the cores drilled from the road.

Several hundred results of tests on steel specimens, however, gave a mean variation of less than 2 per cent, indicating that this value of the mean variation is indicative of certain definite characteristics of the materials tested. We may expect, therefore, to find a greater variation amongst the values from tests of concrete than from tests of steel. If in comparing results of concrete tests, for example to discover the effect of a different method of mixing or other variation in the method of making the concrete, if our results do not persistently show greater than 8 or 10 per cent difference, we cannot draw too nice conclusions as to cause and effect.

Elastic Properties of Concrete Determined by Tests.—In the past few years there has been conducted at the University of Maryland a fairly extensive series of tests to measure the elastic properties of concrete. Such measurements had been made in the past, but from the nature of the apparatus used, the resulting stress strain diagrams were unsatisfactory in that they led to the wrong concept of the elastic curve of concrete, indicating that concrete even under comparatively low stress acted as a material having marked plastic properties, rather than elastic.

For the measurements made at the University of Maryland there was employed a simple arrangement of the mirror extensometer, so that much more accurate and delicate measurements were made possible. The essential fact that these measurements have established is that concrete up to a fairly definite limit acts essentially as elastic material in a manner similar to that which steel exhibits, and that beyond this limit it shows the characteristic stress strain curve for an elastic, plastic material, the limit of the straight line relation indicating the elastic limit which may be about as definitely located for concrete as for steel.

These tests show that the modulus of elasticity for concrete is for all practical purposes a constant up to certain

definite stresses, and that there is no occasion for defining the modulus elasticity of concrete as that at a certain point on the stress strain curve as has been previously reported by some investigators.

The fact that we may treat concrete as an elastic material, and subject concrete structures to analysis by the theory of elasticity is very handsomely confirmed by the results of measurements of the deflection of a concrete road slab under different loads as measured in connection with the Bates Road Tests, and other tests conducted by the Bureau of Public Roads at Arlington. The mathematical analysis of the action of a concrete road slab under elastic conditions is presented by Dr. Westergaard in the Proceedings of the Highway Research Board of 1925 and 1926.

Progress of Construction.—Much attention has been given to factors that would influence the progress of work. Weather conditions that prevail in a large part of the United States make highway construction, of necessity, a seasonal occupation, but as the amount of work to be done has increased, highway engineers and contractors found it necessary to cooperate even more closely than in the past, to the end that everything possible be done to increase the output of finished road. Thus, provision has been made for storage of materials for the winter months, with advance payments for the same; contracts have been let in the fall for the coming season's work, all of which has made it possible for contractors to maintain better organizations throughout the year, with a consequent saving of much time in the spring at the opening of the construction season. Whatever has been done to facilitate work has resulted in economy, not only to the contractor but to the public.

The development of road machinery has played a very large part in speeding up work. In fact, the labor situation has become such in the past few years that unless labor saving machinery had been devised, the work could not have been done. Thus, it has come about that on most concrete jobs but few men are employed who do not handle machinery of some character, reducing to a minimum the purely hand labor portion of the work.

It is necessary only to visit the Chicago Road Show with its enormous collection of road-making machinery of all sorts to realize how great has been the labor saving devices that have been developed, and for the most part but recently developed.

Data as to the progress that has been made are of value to engineers, and reference to these data will be made here. At present, the average yardage per contract for highway work is about 33,000 sq. yd. In 1926, one of the larger contracts was for 169,000 yd. in North Carolina, and one was for 182,000 yd. in Illinois.

Data as to the records of laying concrete roads are found in the November, 1926, "Public Roads" magazine, where it is shown that a mixer turning out the possible maximum batches (48) 13 per cent of the time was for charging, 83 per cent for mixing, and 4 per cent for discharge.

In the Engineering News-Record for June, 1924, page 1063, are to be found some very pertinent data as to the seasonal progress made by different crews on state highway work in Iowa. The record extends for over three years. The average number of feet laid per day was about 270. Pavement was laid on an average of about 70 per cent of the time. Such data as those to be found in this article are of special value in determining the organization necessary to carry on a given season's road-building program.

In general, in the past few years a marked increase in the use of the larger mixers, the No. 28 and No. 32-E, is to be noted, although the 21-E size still remains the one most commonly used.

One of the most complete studies of progress in concrete road construction is to be found in the series of articles by J. L. Harrison of the Bureau of Public Roads, beginning in the November, 1925, number of "Public Roads" magazine. This series should be studied by everyone interested in this phase of the question.

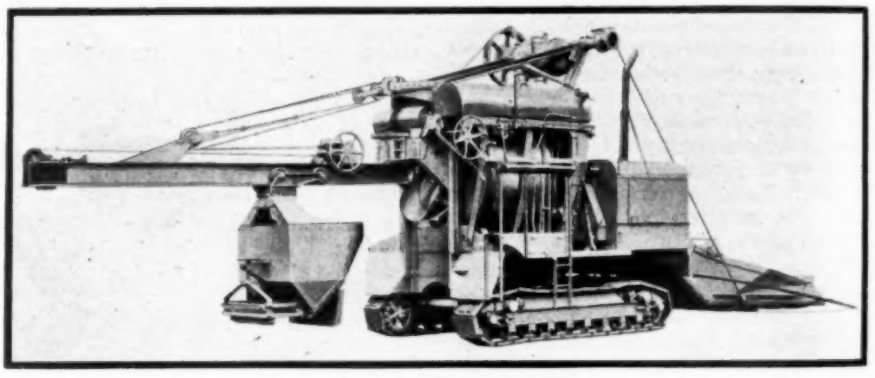
The latest figures obtainable as to the amount of concrete pavement on our highways are the figures compiled by the Bureau of Public Roads up to 1926, which shows a total of 27,875 miles on the state highway systems and 10,106 not on state highway systems, a total of 37,981 miles.

Kansas Road Laws May Be Amended.—Action leading toward a new and stronger road law for Kansas is being taken by the state senate, and a constitutional amendment to cover the situation may be voted upon in another year.

New Rex 27-E Paver

A new foldback top, power take-off and 6-cylinder motor in one unit, and governor booster are some of the important features on the new 1927 Rex 27-E paver. The new paver is stated to be the fastest ever built by the Chain Belt Co. In addition to speed, new features have been added to synchronize the charging and discharging to keep two batches going through the paver all the time.

All operating levers are bronze mounted to permit smooth easy operation and control. These levers are so grouped as to permit two or more operations to take place at once. Charging, discharging, and getting water into the drum are now done in the time ordinarily devoted to charging alone. To accomplish this it was necessary to accurately time all three operations and allow for variation on different jobs. The operator now has at his command a faster mixing cycle which, it is claimed, can save as high as 40 paving minutes in a day's work.



New 1927 Rex 27-E Paver

Another new feature is the unit power plant employing a 6-cylinder gasoline engine. The power take-off is a part of the unit and consists of direct speed reduction through heat treated cut tooth gears. These heat treated gears are inclosed in a case and run constantly in oil. By this new improved arrangement, it is stated, vibration is completely subdued and reserve power is always at hand.

The new foldback top is entirely power operated and may be raised or lowered in a few minutes time. The water system rests crosswise on the foldback top and the complete unit is lowered without dismantling the entire system. Water control is very rapid and accurate to the pint, requiring but 7 seconds to discharge the correct quantity into the drum.

Other important improvements are heat treated steel mixing blades and buckets, drop forged gears, alloy steel shafting and a spiral lime proof cooling system. This cooling system is especially valuable for cold weather paving as water of an even temperature may be used in mixing the batches.

Bituminous Paving Mixture Researches

Test Apparatus Developed by U. S. Bureau of Public Roads Described in Paper Presented Before 5th Annual Asphalt Paving Conference

By W. J. EMMONS
Highway Research Specialist, U. S. Bureau of Public Roads

During the past year research on bituminous mixtures has been vigorously prosecuted by a number of organizations. Although attention at present is focused principally upon the development of a test which will define the resistance to displacement of any mixture when subjected to conditions of service, the basic motive behind such research is the formulation of a rational theory of design or the substantiation of an existing theory.

At the Bureau of Public Roads two pieces of apparatus are in process of development which it is hoped will assist in the solution of the problem. Neither apparatus is perfected but it is felt that a description of the work being done should prove of interest at this time.

Roller Machine for Testing Bituminous Pavement Section.—A machine which attempts to duplicate to a certain degree the action of traffic on a pavement surface has been designed for the purpose of determining the comparative strength or resistance to displacement of bituminous mixtures. Figure 1 shows in diagrammatic form the arrangement of this machine. The essential feature is a series of 11 steel cylinders or rolls, 4 in. in diameter by 3 in. long, mounted between and near the peripheries of two confining steel disks, which in turn are rotated by a motor. Beneath the rolls is a watertight bath or tank in which is placed the specimen to be tested. At the beginning of the test the rolls are lowered

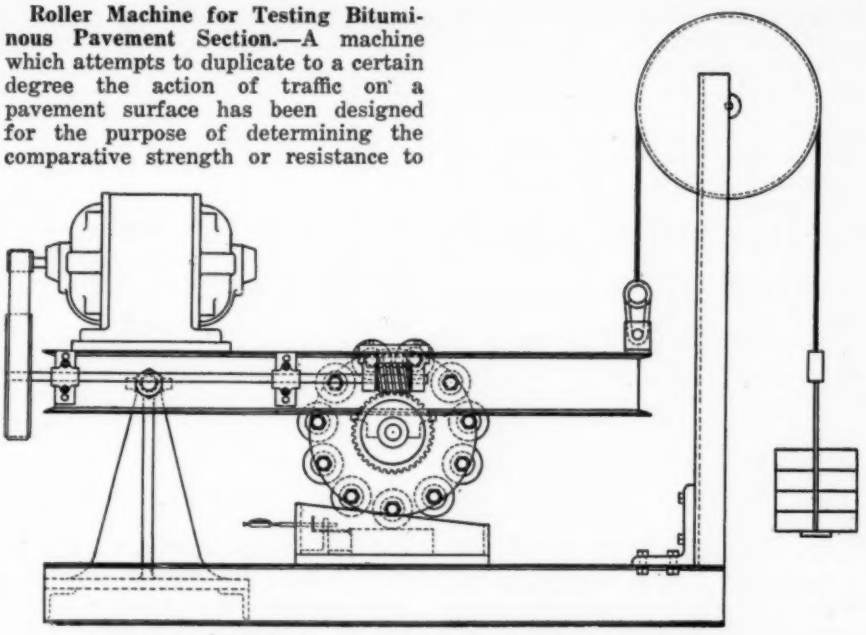


Fig. 1—Roller Machine for Testing Bituminous Pavement Sections

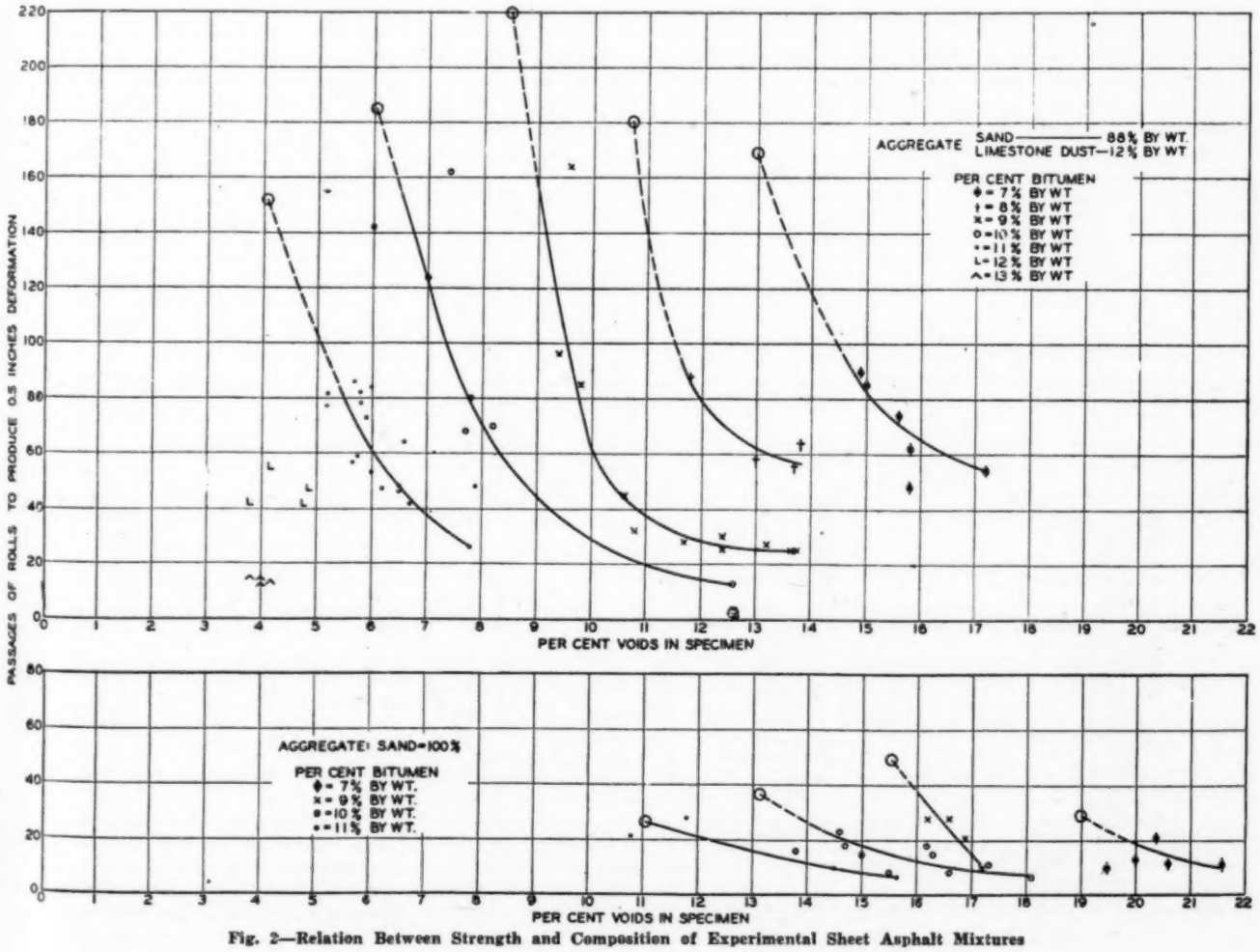


Fig. 2—Relation Between Strength and Composition of Experimental Sheet Asphalt Mixtures

gently to the surface of the specimen and the motor started. Rotation of the rolls takes place as they pass over the specimen, tending to deform it longitudinally. A certain amount of impact is also imposed as each roll leaves the specimen and the following one comes in contact with it. A small metal plate held lightly against the end of the specimen and connected with an Ames dial by a brass rod constitutes the device for measuring deformation.

The specimens are prepared by hand mixing and are compacted in a rectangular collapsible steel mold by means of an electric hammer fitted with a square tamping end. Specimens 8 in. x 6 in. x 2¼ in. have been used in most of the work thus far, although at present the behavior of a smaller size of specimen, 8 in. x 4 in. x 2¼ in. is being investigated. In each case the face of greater area is exposed to the action of the machine.

Results of the Test With Roller Machine.—As might be expected, widely different test values may be obtained by varying the conditions of the test. An arrangement of the machine and of the specimen was sought which would give a wide range in strength values between weak and strong mixtures. The weight imposed by the rolls is susceptible to adjustment by means of counterweights to a maximum of 450 lbs. and the speed of rotation may be varied from 4 to 10 r.p.m. The degree of support provided the specimen under test greatly affects the results and it has been found best to confine it in a frame on the rear and two sides. The end toward which the movement takes place has at times been left entirely unsupported but it is probably better to insure against slipping of the entire specimen by providing small plates partially closing the fourth side of the rectangle.

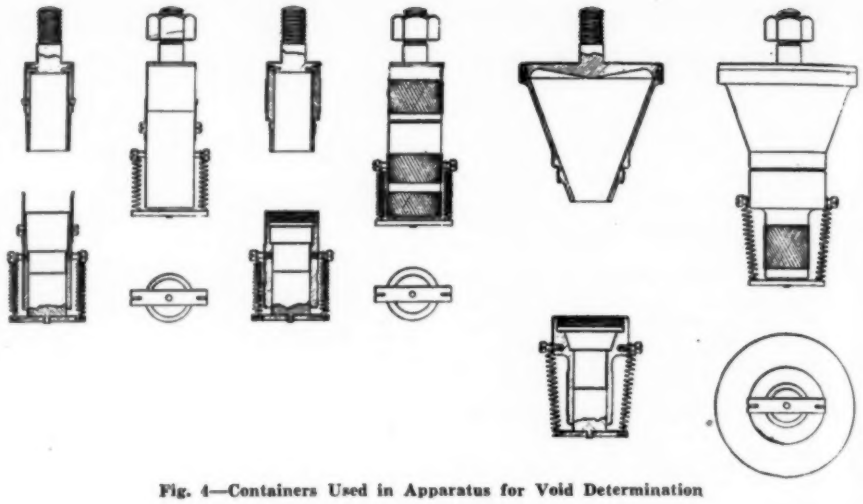


Fig. 4—Containers Used in Apparatus for Void Determination

For the purpose of bringing out the effect of these many variables, rather than of deriving definite information regarding mixtures, many short series of tests have been run. The typical series shown in Fig. 2 were made using 8 in. x 6 in. x 2¼ in. specimens, a machine speed of 7 r.p.m., a load of 250 lbs., and a testing temperature of 60° C. The aggregate was held the same for all the specimens of each group of curves, the bitumen being varied as indicated.

Several indications regarding the test are evident from the chart. The test appears to differentiate clearly between mixtures varying in bitumen and dust content. It is very sensitive to slight variations in the density of well-compacted specimens. It is also apparent that a series rather than a single test is required to define the characteristics of any mixture. The failure of certain specimens to check with the average of their respective groups may be due to lack of uniformity in their densities or to certain other conditions of testing or molding which are as yet not clearly understood.

Considerable thought has been given to the method of interpreting curves of this nature. It is evident that data in this form are of little practical value without a knowledge of the degree of density to which mixtures may be compressed in service. Comparatively little information is available but a study is being attempted which it is hoped will shed light on the matter. As a step in that direction dry aggregate voids tests are being made on the aggregates extracted from samples of pavements of different ages, and the results of these tests are compared with the computed voids of the aggregate as it exists in the original sample. Insufficient work has been done to warrant definite conclusions, but from the tests which have been made, it is indicated that the voids existing in an aggregate may afford a measure of the compressibility of that aggregate when combined with bitumen.

As a tentative method of comparison between mixtures, the curves of Fig. 2 are extended to the point of maximum possible compression indicated by the voids tests upon the aggregates. Unfortunately, these series do not include enough tests to define the slope of some of these curves as well as might be desired but it seems that with percentages of bitumen which are less than sufficient to fill the voids in the aggregate, a compression can be attained which is, as a rule, within one per cent of the computed maximum possible density.

Apparatus for Determination of Voids.—Another device developed by the Bureau of Public Roads is a mechanical means for compacting fine aggregate mixtures in the test for voids. This apparatus is shown by the draw-

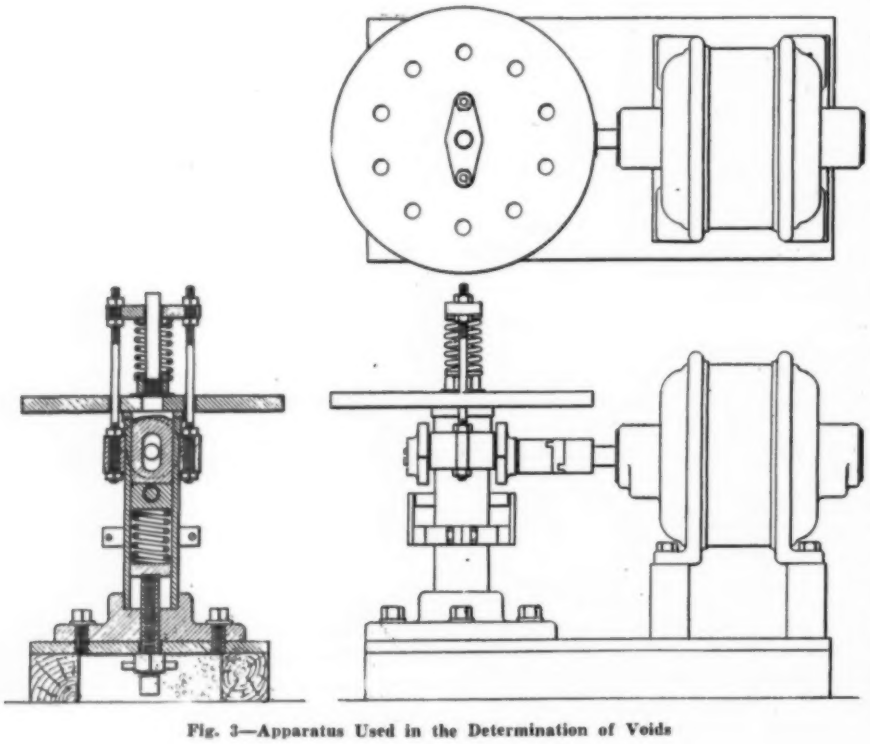


Fig. 3—Apparatus Used in the Determination of Voids

ings in Fig. 3. A steel disk 11 in. in diameter and ⅛ in. thick carries the aggregate containers and is vibrated rapidly between the lower and upper springs. Two cams driven by the motor are attached to the shaft, passing through the central column of the machine, alternately compressing and releasing the lower spring at the rate of about 1,500 times per minute. The throw of the disk is adjustable up to a maximum of 0.04 in.

Fig. 4 illustrates the types of containers which have been used to hold the aggregate being tested. The disk of the vibrator is perforated with ten ⅝-in. diameter holes equally spaced on a circle concentric with its circumference. The bases of the containers are equipped with threaded rods by means of which they are bolted to the machine. Either cylinders or cones may be used to contain the aggregate. Each container is fitted with a removable sleeve which may be atached to the container by spring clips or by threads. At the beginning of the voids test, the sleeve is attached, slightly more aggregate than is necessary to fill the calibrated container is introduced, a rubber shod cylindrical metal plunger is placed over the aggregate and the whole apparatus bolted to the vibrator. A 20-minute period of vibration has thus far been employed although it is likely that a somewhat shorter time may be sufficient to produce thorough compaction.

Considerable trouble has been experienced in obtaining a design for the containers which would resist the severe use to which they are subjected. The screw thread type has virtually been discarded since it was found all but impossible to prevent dust from seeping into and ruining the threads of the containers. The spring clip type seems to be more durable but as the holes in the clips wear larger it has been found necessary to take up the looseness which develops by wrapping and compressing a rubber band between the shoulder of the container and the sleeve.

Cylinders should be made by boring a solid steel rod in order to insure the greatest rigidity. Certain of the cylinders originally made have of late given erratic results and this has been traced to a very slight looseness which developed between the bases and the walls which, in this case, were turned out separately and assembled.

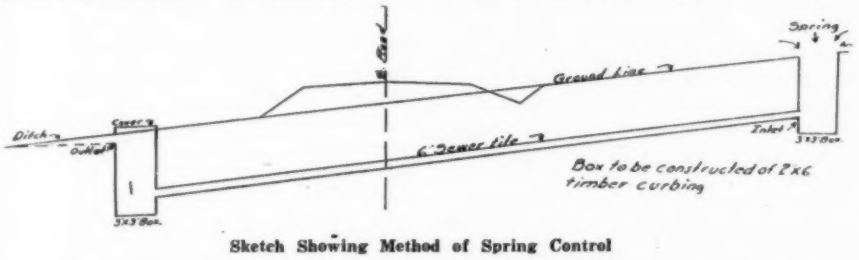
Most of the work has been done with cylinders 1 in. in diameter and of approximately 26 cc. capacity. Determinations by the method of hand tamping have been made concurrently with the machine test, using containers of identical construction for both purposes. Voids have also been calculated as they exist in 2-in. diameter cylindrical specimens of sheet asphalt mixtures compressed by the method devised by Messrs. Hubbard and Field. The aggregates of these specimens were combined with percentages of bitumen from 7 to 14 per cent.

On the basis of the work done thus far it is believed that in the very near future the vibration method may be developed to give at least as complete compaction as can be obtained by either the more laborious hand method or by the method of direct compression under a predetermined load.

Control of Sidehill Spring Drainage

A condition that has caused much trouble on North Dakota roads was overcome during the past season. We are indebted to an article in the North Dakota Highway Bulletin, by J. E. O'Neill, Construction Engineer of the State Highway Department for the following detail:

Where roads are located below springs, a great amount of difficulty is caused by these springs which flow continuously during the winter months and in running through the culverts the water cooling rapidly it freezes and forms thin sheets of ice, finally entirely blocking the opening and eventually covering the entire road surface with ice, and thereby creating a dangerous and almost impassable road.



Sketch Showing Method of Spring Control

An illustration of the above condition was encountered on F. A. P. 260, Section—B, Morton County, on State Highway No. 3, between the towns of Glen Ullin and Hebron. A spring on the side hill made the road impassable during the winter of 1925-1926 by continually freezing and finally covering approximately 200 ft. of the road surface with a thick coat of ice, which naturally froze higher on the spring side and created a side hill condition so that cars venturing across slid into the ditch. Also, during a few warm days the spring water melted a trench across the roadway and thus making it impossible to pass. This condition was entirely overcome by constructing a catch basin at the location of the spring and piping the water under the roadway at a depth below the frost line to a second catch basin at the lower side of the road which outlet was kept from freezing by a certain warmth of the spring water, as well as by considerable pressure caused by the higher water elevation of the upper catch basin. The flow is kept constant and to date there is no sign of any trouble as was the case in the past at this location.

Proposed Specifications for Concrete Curb and Gutter

Recommendations of Committee S-6 to 23rd Annual Convention, American Concrete Institute

This data, abstracted with permission from the copyrighted proceedings of the American Concrete Institute, sums up the tentative standard specifications for concrete curb and concrete curb and gutter as proposed by the committee appointed to study the subject.

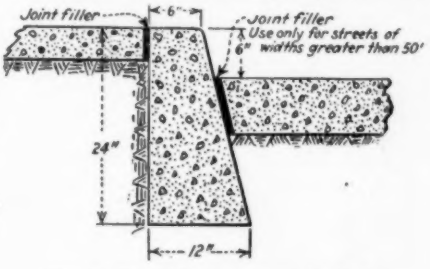


Fig. 1—Dimensions of Separate Curb

The subgrade should be excavated to sufficient width and depth and depressions filled by compacting 4 in. layers of suitable material into them. Subgrade to be wet when concrete is placed. Standard specifications for materials are followed. Metal forms and division plates, oiled, are required. Dimensions specified for separate curb and for combined curb and gutter are shown in the two drawings.

A mix approximating 1:2:3 is recommended, machine mixing of 1 to 1½ minutes advised, and concrete is to be placed and tamped and spaded in layers of 4 to 5 in. After forms are filled, the concrete is to be struck off with a template, and finished with a wood float and edging tool. Forms are to be stripped in 24 hours. Final finishing with wood block and water is required to give desired surface texture. The curb is then to be cured by keeping it damp for seven days. Half-inch expansion joints to be afforded at each curb return, and at specified intervals. Corners at curb intersections are to be rounded with a curve of at least 20 ft. radius.

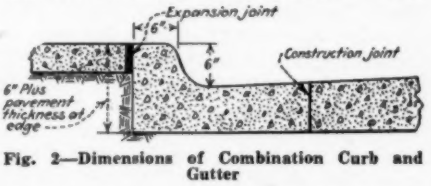


Fig. 2—Dimensions of Combination Curb and Gutter

Cement Factor Needs Watching

How a Contractor Can Lose Money by Overrun and Also by Underrun, as Told in The Scraper

By D. V. TERRELL
Engineer of Tests, Kentucky State Highway Department

Cement Factor has worried paving contractors perhaps more than any other one thing dealing with paving material. Cement factor as referred to here means the number of barrels of cement used per cubic yard of concrete. When a contractor is awarded a paving contract he moves on the job and starts his mixer, he begins to figure how much cement he should be using based on the number of feet of pavement laid. He usually makes his calculations on some arbitrary cement factor, taken from tables or cards intended for general use in estimating. When he finds that he has an overrun of 40 to 100 bags of cement per day, he then starts in to find out what is wrong and why he has such so-called overruns, and usually winds up by criticising the Engineering Department and asking for relief through that body.

This article is intended to point out to the contractors the reasons for this so-called overrun, so that they may more nearly arrive at the correct cement factor when making up their estimates. Any bid by a contractor is an estimate upon which he matches his experience and skill against other contractors; sometimes he may feel that he has been misled by the Engineering Department and therefore, underestimates the amount of cement he would have to use.

The Kentucky Specification.—The 1926 specification reads as follows: (A) "326. TOLERANCE IN THE AMOUNT OF CEMENT USED. The Contractor and Engineer shall at all times determine the proportions of the mixture by measuring the volume of cement, fine and coarse aggregates, entering the mixture. However, in order to determine whether or not the exact proportion is being secured each and every day, the Engineer will determine the exact amount of cement required to produce a cubic yard of concrete from the aggregates to be used and for the mixture specified. From this and the number of bags of cement used the Engineer will calculate the number of cubic yards of concrete that should have been produced and compare this with the amount of concrete actually produced in any day, and if this method of check shows that the amount of cement used is repeatedly falling below the amount required for the mixture, the mixer will be closed down until suitable means are adopted insuring the Engineer that the proper mixture will be secured. And if the amount of cement used is seven and one-half (7½) per cent or more, less than the amount required by any day's run, the Department reserves the right to require the Contractor to remove all pavement laid that day and replace same in accordance with these specifications."

No Factor Given.—It will be seen from the above paragraph that no cement factor is given the contractor, but that the factor for the aggregate to be used is to be calculated by the testing laboratory. It is expected that this factor will be worked out for each two miles of pavement or whenever there is any noticeable change in the aggregate. This factor so obtained is to be balanced against the actual count of bags used in the field. It also states that the contractor must keep up to the factor set; if he repeatedly falls below the work will be stopped until there is an adjustment and if as much or more than 7½ per cent low he may be required to take out the day's run and relay it.

The proportioning of the cement, fine and coarse aggregate must be done by volume and as specified. For concrete pavement the mix with standard aggregates is 1:2:3.5 and cannot be changed except with approval of the Frankfort office.

Since all of the material must be measured by volume and that amount is fixed, no one can tell exactly what the cement factor will be, because it will change slightly with different gradation of the aggregate.

For the 1926 construction season very close check was kept on the cement factor to determine how the laboratory calculations checked with the field records. These results are shown in the following table:

Project	County	Kind of Aggregate	Cement Factor as Calculated by Laboratory	Cement Factor by Actual Count in the Field
		(Standard Mix 1:2:3.5)		
S. P. 105A	Kenton	Gravel	1.51	1.50
F. A. 137A	Bath	Gravel	1.51	1.51
F. A. 114A	Grant	Gravel	1.51	1.65
F. A. 88	Rockcastle	Stone	1.63	1.70
F. A. 151	Bell-Harlan	Stone	1.63	1.66
S. P. 35C	Whitley	Stone	1.63	1.63
		(Special Mix 1:1.6:3.2)		
S. P. 8E	Daviess	Gravel	1.75	1.79
F. A. 122A	Hopkins	Gravel	1.75	1.83
		(Special Mix 1:2.0:3.2)		
S. P. 57A	Mason	Gravel	1.55	1.55

Laboratory records for standard aggregates such as used in this state show from calculation and trial that for a 1:2:3.5 mix a cement factor of 1.50 to 1.55 may be expected when gravel is used and 1.60 to 1.65 when crushed stone is used. The cement factor as shown by the fixed count should always be higher than the factor worked out in the laboratory.

If the thickness of the pavement is specified as 6 in., the contractor must figure on not less than 6 in., which means that he will run 6 to 6¼ in., and should, if he wishes to be on the safe side, average 6⅛ in., therefore, the entire volume of concrete would be increased by 2 per cent, but since only the theoretical section is used in the calculation the apparent cement factor is increased by 2 per cent.

If the laboratory estimates with a given aggregate that the cement factor should be 1.52, in the field the factor should work out 1.55; if the laboratory finds it to be 1.62, the field should get 1.65.

Low Subgrade a Factor.—Low subgrade plays a very important part to the contractor in keeping down this so-called overrun on cement. He may work his subgrade as near six inches as possible, but he cannot afford to allow thin pavement to go in, so that he may save a few bags of cement. For instance, if he should lay one mile of pavement, which showed an average thickness of 5⅞ in., he would save about $200 worth of cement and lose more than $1,000 in penalties for thin pavement.

All paving contractors are advised to read carefully paragraph 344 of the 1926 specifications, which describes the manner and method of core-drilling a pavement in order to determine the thickness. It will be seen from this paragraph that not more than 5 cores will be drilled per mile, except when a core drilled is less than 5 in., in which case the section under 5 in. in thickness will be determined by additional drilling. In no case will additional cores be drilled with the idea of bringing up the thickness of the pavement.

In averaging the five cores drilled per mile to determine the thickness of the pavement, all cores measuring more than 6½ in. will be counted as 6½ in. and those under 5 in. will be thrown out and that length deducted and not counted in the average.

Each mile will be averaged separately and will begin and end according to the station numbers used in construction.

Cost of Scant Thickness.—To show what the reduction may amount to for thin pavement, the following table has been prepared: (Column 1 lists "Thickness of Pavement"; Column 2 shows "Per Cent of Contract Price per sq. yd. that will be allowed the contractor" for each thickness.)

1.	2.	1.	2.	1.	2.
6 in. or more	100.00	5.70	90.25	5.30	78.03
5.95	98.33	5.65	88.67	5.20	75.11
5.90	96.69	5.60	87.11	5.10	72.25
5.85	96.06	5.55	85.56	5.00	69.44
5.80	93.44	5.50	84.03	Less than 5 in.	Nothing
5.75	91.84	5.40	81.00		

The above table shows what per cent of the contract price per square yard the contractor will be able to collect for thin pavement.

If the average for any one mile should drop below 6 in., say 5.9 in., then the contractor can only collect 96.69% of his contract price per square yard. If his price was $2.40 per square yard he would be paid for this mile $2.32 per square yard and on an 18 ft. pavement would lose $844.80. If every mile on the job was over 6 in. except this one, and if the average of the whole job was over 6 in., the reduction for this mile would have to be made.

It is clear that the contractor must consistently keep his pavement to or greater than the required depth and by so doing his cement factor will increase from 2 per cent up in accordance with the extra thickness.

Because of all the conditions stated above it is not possible to say what cement factor the contractor should use in estimating a paving job, but as a bit of advice it is advisable to figure it in high enough so that he will not always think that he has an overrun when in reality he is only using the cement that he should use.

During the past construction season some contractors used too much cement because their subgrade was too low, others used too little because the subgrade was too high and in the latter case will no doubt prove disastrous to the contractor. About half of the projects reported used about the correct amount of cement.

Improvements in Littleford Kettle

Littleford Bros., of Cincinnati, O., are incorporating some new features in their oil burning tar and asphalt melting kettle, type No. 84-W. These features consist of a removable windshield to protect burner, a new design of cover, and a front splash guard.

The windshield is made of steel plate and completely surrounds flame of torch, eliminating all possibility of wind interfering with operation of burner.

Improved Littleford Kettle

The cover is made in two sections as heretofore; however, one section is bolted down and the other is hinged to it. This construction makes it impossible for the cover to be jolted out of position. The hinged section lays on top of stationary section when open. Under the hinged section of cover a grid is now provided, on which barrels may be placed for draining. This grid is removable.

The front splash guard is located at top of melting tank and consists of a steel plate extending horizontally inside of tank 3 in. and then flanging down ¾ in. This guard prevents contents from spilling out front end of tank when kettle is jolted. At rear end of tank, the bolted-down section of cover accomplishes the same result.

The Littleford oil burning melting kettle No. 84-W is made in three capacities: 50, 75, and 110 gal.

New Wide Track Crawler for Fordson

The Belle City Manufacturing Co. of Racine, Wis., has just put into production a wide track crawler for Fordson as a companion to their narrow track, which has been in successful use for some time both at home and abroad, working under the various difficult conditions required of this type of tractive power.

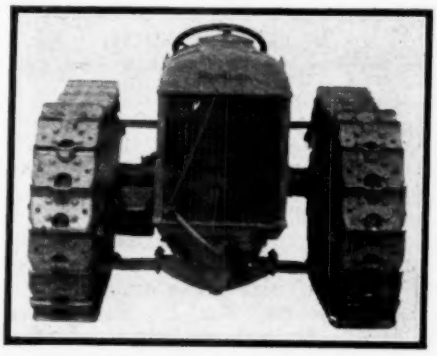
The new model is styled standard gauge, and like the narrow gauge is clutch controlled, has full Timken roller bearing equipment, Alemite-Zerk oiling system, drop forged treads and saw steel clutch discs running in oil.

The standard gauge has the same measurement between treads as between regular Fordson drive wheels, uses any standard drive pulley and accommodates any industrial equipment used on the wheel equipped tractor and that without any special attachments.

The additional width of this model is obtained:

First. By substituting for the regular Fordson axle housings, internally ribbed steel housings of the same contour and with the grooves used for attaching equipment exactly the same distance apart as in the regular housings.

Second. To provide a front end or third point of suspension for the tractor a heavy cast steel saddle or walking beam is pivoted on a shaft passing through the Fordson front axle stirrup and to this walking beam is bolted on either side heavy leaf springs whose outer ends are connected to the main frame assemblies by means of steel shackles. This assembly acts as a radius link and provides flexibility to the tracks. When heavy equipment is attached to the crawler requiring a connection to or the support of the front axle, then the springs are replaced by heavy steel members attaching in the same manner as the springs. The steel axle is equipped with rubber bumpers which act as shock absorbers.



New Wide Track Crawler for Fordson

Third. Ample additional strength and rigidity is given the main frame assemblies by the use of a 1½ in. special steel radius rod or spacer which connects these two assemblies passing under the tractor crank case.

Much stress is laid upon the accessibility of all working parts and the simplicity of design.

89 Per Cent of Gas Tax Goes for Road Purposes

All but four states—Illinois, Massachusetts, New Jersey and New York—collect a tax on the gasoline sold within their borders at rates ranging from 1 to 5 ct. per gallon. Although a form of sales tax, it is generally conceded that the gasoline tax is in essence a type of road toll and that its yield and earnings reflect more or less directly the use made of the highways by motor vehicles and measure to a certain degree the benefits resulting therefrom.

The disposition of the funds collected in this manner varies in different states. An idea of the average apportionment may be had from an analysis of the figures of 21 states made by Henry R. Trumbower, economist of the Bureau of Public Roads, United States Department of Agriculture. According to this analysis, 89 per cent of the net gasoline tax receipts is used for the construction and maintenance of rural highways, 67 per cent being devoted to state highway systems and 22 per cent to the construction and maintenance of local roads. The remaining 11 per cent is also used for the most part for road and city street purposes. The gasoline tax is a comparatively new method of raising funds for highways and is continuing to furnish a more and more important source of funds for road use.

Michigan Super-Highways

Extract from Address Presented Feb. 4 at Michigan Engineering Conference

By LEROY C. SMITH
Engineer-Manager, Wayne County Road Commissioners

The Board of Wayne County Road Commissioners, in 1906, launched a highway improvement program with an initial appropriation of $85,000. This was divided, as has been the custom in most communities starting road improvement work, into a number of short stretches of road. The desire in that day was to get out of the mud. In an ambition for mileage better judgment as to width was sacrificed and several improvements were made with a paving width of 12 and 14 ft. Today, 20 years later, appropriations for highway improvement by Wayne County exceed $5,000,000 per year, and the writer believes that the necessity for present-day expansion is as great as ever before.

Twenty years ago a county road improvement consisted of some drainage and grading and the application of a road metal—probably stone or gravel.

What Today's Highway Improvement Includes.—Today the improvement of a highway includes a wide grade, a wider right-of-way, a pavement 40 ft. or more in width; it includes the construction of necessary bridges over streams; grade separations with main-line railroads; direction signs, safety signs and lights; comfort stations for the convenience of the traveling public; beautification of the roadside; sodding, planting of young trees and preservation of existing trees. All these things are necessary and must be provided for, just the same as stations, yards, and terminals have been provided for railroads. A highway system which does not provide safety and convenience is lacking.

Since the inauguration of a road-building program in Wayne County, 6,000,000 sq. yd. of concrete pavement have been laid, 55 modern bridges and 22 grade separations have been constructed, 25,000 trees have been planted and 10 public comfort stations have been built.

As for the physical improvements in the great network of highways in this district has improved, it became apparent to the builders that additional space for right-of-way should be provided for future expansion. If immediate action were not taken towards the acquiring of future widths, the very cost of the projects would defeat them.

The Master Plan. — In cooperation with the Detroit Rapid Transit Commission, the counties of Macomb, Oakland and Wayne launched a plan for the acquiring of future thoroughfare rights-of-way, which in the years to come will do more towards the solution of congestion than any other single act approved by the governing bodies of the counties concerned. This plan has been called the Master Plan, a very appropriate name.

It is briefly described by laying the territory out with a gridiron of superhighways 204 ft. wide every three miles, north and south, east and west, making every section line road 120 ft. wide and every quarter line road 86 ft. wide. These great highways cover the entire territory within the 20-mile circle of Detroit. They approach the city and enter it to approximately the six-mile circle. It is unfortunate that the plan could not have been launched years ago and the public had the benefit of 204 and 120-ft. highways on the main thoroughfares of Detroit right down to the city hall.

This was not unthought of by the men who planned Detroit, for in 1806 the Governor and Judges plan called for many 200-ft. highways and 120-ft. streets. Washington Boulevard, Cadillac Square and Jefferson Avenue East are the remaining remnants of such a plan. Had that plan not been encroached upon by less far-seeing successors our traffic problems would be lessened to a great degree.

Many of our far-seeing business men still believe that the solution of the down-town traffic problem should come through the opening up of great thoroughfares 200 or more feet in width. This would provide a means of individual transportation which could only be equalled by subway or elevated trains.

Wide Thoroughfares in Suburban Region.—The launching and the approval of the Master Plan immediately brings desirable results. A policy has been adopted by the road commissions of the three counties named of making no road improvement except that the right-of-way shall conform to this general plan and that the funds for that right-of-way must be provided for in connection with financing the road. Again, the Master Plan has been placed upon record with the Register of Deeds and Platting Boards of the counties concerned, thereby making it necessary that when land is subdivided, right-of-way in accordance with the Master Plan shall be dedicated to the public. This provision alone is saving millions for the taxpayers of this territory in future road and street widenings.

The question is often raised, especially by those unfamiliar with Detroit territory, as to the necessity or advisability of a highway 204 ft. in width.

Who can say that Washington Boulevard is too wide or that its width is a detriment to property facing thereon. Its very width has made abutting property valuable. The great thoroughfare, —Woodward Avenue, is 200 ft. wide. With its two pavements 45 ft. in width, ample space between the curb and buildings for utilities and central strip which may be utilized for parkway, rapid transit or whatever may be developed for the good of the community is provided for all time to come.

The Master Plan changes the Detroit area from a spoke-of-the-wheel city layout to the gridiron system. This makes possible and encourages the building of new centers. The intersection of two superhighways leads to a business development. If the Master Plan does nothing more than to spread the population over larger areas it will have been worth its cost.

The Superhighway Commission.—To make effective and uniform the principles outlined by the Master Plan, Oakland, Macomb and Wayne Counties are bonded together through what is known as the Superhighway Commission. This commission consists of the boards of road commissioners of the three counties and the state highway commissioner.

Their function is to acquire right-of-way only. Funds may be raised to the extent of one-half mill tax upon the assessed valuation. Laws are available whereby the benefit of wide highways may be assessed upon the property.

Much has been said about co-ordinating the efforts of the various governmental agencies of cities, villages and counties towards a common end. I know of no combination of commissions or boards which have accomplished so much without the expenditure of money as has been brought about through an agreement on the Master Plan by the officials of Detroit, Wayne County, Oakland County and Macomb County.

Through the cooperation of the State Highway Department the greatest superhighway development has been made on Woodward Avenue. The next big project is a great east and west thoroughfare, the county line between Oakland, Macomb and Wayne counties—the Eight Mile Road. This is to be accomplished through the operation of the Assessment District Act, commonly known as the Covert Act.

Example of Superhighway Treatment.—The improvement of a superhighway right-of-way must be determined by the needs of the territory traversed at the time each step in the improvement is taken. Several different examples of treatment exist in the Detroit Metropolitan Area.

Much of the 204-ft. right-of-way on Southfield Avenue has been dedicated, although at the moment the traffic is being well taken care of (except on Sundays and holidays) by a single 20-ft. strip of concrete centrally located. There are no interurban tracks on Southfield.

How and when the superhighways are to be developed is not nearly as important as is the early acquisition of the right-of-way itself. It is important that the land necessary be acquired now, before improvement in the shape of expensive buildings makes acquisition expensive or impossible.

Work has already been started on Fort Street Superhighway. This passes through the City of Lincoln Park and on the city line of Wyandotte, connecting up all the down-river cities, and with the approval of Detroit's common council the 204-ft. width will be carried within the City of Detroit as far as the River Rouge-Fort Street bridge. This bids fair to be Wayne County's greatest highway.

Mack Avenue, from Cadieux Road northeasterly, will be carried out through Wayne and Macomb counties, over 30 miles, passing around the bottleneck in Mount Clemens and connecting at New Baltimore with state trunk line No. 27, thereby relieving Gratiot Avenue congestion.

The Northwestern Highway, a radial road bisecting the territory between Grand River and Woodward Avenues, is already launched as a right-of-way project between Oakland and Wayne counties. It pierces the city limits of Detroit 3 miles, thereby connecting up many important north and south and east and west thoroughfares.

Proper planning now, and the agreement of the three counties upon a program of development for years ahead, in accord with the future growth of Detroit and her neighboring cities and territory, does not at this time cost an excessive amount but in the future may well save tens of millions of dollars.

New 1-Yd. Diesel Shovel

A new D-2 1-yd. Diesel shovel, convertible to dragline, clamshell and crane, has just been put on the market by the Bucyrus Co., South Milwaukee, Wis.

The power plant of the D-2 is a 4-cycle full-Diesel engine. The fuel is fed into it mechanically, providing high economy of fuel consumption and avoiding the use of air compressor. In addition, the engine can be started from stone cold to full load in 20 seconds, no priming and preheating being necessary. The engine is mounted on a raised base which is bolted securely to the cast revolving frame—a mounting that provides a direct connection between the main machinery and engine, and which insures perfect alignment at all times.

The Bucyrus center pintle construction relieves the vertical propelling shaft of all digging strains, and keeps the revolving frame centered on the base frame and protects the vertical propelling shaft from wear and breakage.

A patented rope crowd is used on the machine, which makes it possible for crowding and hoisting operations to take place individually as well as simultaneously. The new straight boom of the D-2 Diesel has all the advantages of the Bucyrus bent boom, with the added advantage that the machine operates better with the boom at low angles. Since this boom is lighter, the machine has a quicker swing and better stability.

The two-part hoist and the big drum used in the main machinery and on the boom insure proper tracking of the ropes and lengthen their life. Outside dipper handles insure that the full force of the engine is transmitted squarely behind the dipper. The lightweight box girder boom with outside dipper handles require less counterweight at the rear of the D-2 shovel—there is less flywheel effect to act against the swinging machinery, making the D-2's swing fast at every stage.

An outstanding feature of the caterpillar mounting of the D-2 is its simplicity and fewness of parts, with more than sufficient tractive power to enable the excavator to climb up inclines as steep as 30 per cent.

Bucyrus D-2 1-Yd. Diesel Driven Shovel

Grade Crossing Accidents in 1926.—The American Railway Association reports an increase in grade-crossing accidents during 1926. Throughout the United States there were 5,921 crossing accidents last year, in which 2,492 persons were killed and 6,991 injured, while in 1925 there were 5,479 accidents in which 2,206 persons were killed and 6,555 injured.

Gravel Road Maintenance

How Calcium Chloride Is Used in Ionia County, Michigan, Described in Paper Presented Feb. 16 at Highway Engineering Conference, University of Michigan

By ALLEN M. WILLIAMS
Engineer Manager, Ionia County Road Commission, Ionia, Mich.

The function of calcium chloride in the maintenance of gravel roads is due to its ability to take out of the atmosphere about three times its own weight of water. This moisture adheres to the dust particles and prevents their otherwise being blown away.

Method of Application.—As soon as the frost leaves the ground in the Spring we endeavor to get the road patched, that is, all depressions filled and a loose floating mat provided the entire length of the road. This is usually accomplished before the Spring rains cease and the roads become dusty.

An application of chloride is then in order so that as much as possible of the fine material or binder is saved from blowing away. Just prior to the application of chloride, however, the road is floated and put in shape to receive it. The chloride is allowed to dissolve and penetrate the road surface before being scraped again, which is usually the next or second day after the application.

The chloride is loaded on trucks either from storage or directly from the car and carried out to the road which has been prepared to receive it. An ordinary lime drill is then hooked to the rear of the truck and the chloride dumped from the sacks directly into it. The truck is started ahead as the ports are opened in the lime drill. The truck drives at a rate of from 4 to 6 miles per hour until the load is exhausted. It is very important that the distribution be as even as possible; however, some conditions may require more and some less.

The drill is either then switched to another truck and the process continued, or the original truck is reloaded from feeder trucks. The former method is more economical as it saves one handling of the chloride. The second method may be found more convenient in some instances. The driver of the spreading truck should drive at a consistent rate of speed parallel to and a little to the right of the right hand traffic lane so that if any gap is left it will be in the center which will gradually become treated due to the floating action of the road scraper.

An 8-ft. lime drill is used and two widths are usually sufficient to treat a 24-ft. gravel road.

Amount of Calcium Chloride.—There is a difference of opinion among engineers as to the proper amounts of chloride to be applied and the treatment will vary from two and one-half to five tons per mile. The Michigan State Highway Department's estimate of $30 per ton is very close to the actual cost; however, there may be a small variation one way or the other. The shipping of chloride in 100-lb. sacks is a very convenient way to handle it and provides a means of checking the distribution.

The fine particles are as essential to the bond of a gravel surface as the gravel that makes up the coarser aggregate. A light loose mat of fine material is indispensable as a protection to the bonded part, as it takes up the slippage and skidding of the wheels of traffic. This naturally produces wear which reduces the size of the material and powders some into a dust. Besides being a deterioration of the road, it becomes a menace to comfort and safety as well. The fact that gravel will not bond until sufficient fine or cementing material is either added or produced from wear proves this need. When scarifying, the hardest roads to break disclose that the grading of material must be from the very finest to the maximum size stone allowable, and enough fine material to completely fill the voids.

In discussing this subject, the retaining of the fine aggregate in its place is that with which we are particularly concerned. The loss of the fine material due to being blown away varies in an inverse proportion to the amount of moisture in the surface within a certain limit. The loss by wind, however, is always great enough so that a surplus does not collect and become bothersome. The dust is the cement, and in adding new material the percentage of cement must be large enough to replace that which is lost and is best added in the form of limestone or clay. This also adds to the effect of the chloride where chloride is used.

As the action of traffic and the elements is to start the ravelling of the road surface by releasing the finest of the fine material first, it is important to employ some agent which will prevent the dust from being carried away where the volume of traffic is such as to warrant its use.

Let us consider the destructive elements which tend to dislodge the particles that make up the surface of a gravel road; namely:

1. Traffic: a. Abrasion; b. Skidding; c. Vacuum created by tires; d. Air currents created by the vehicles.

2. Water: a. Rain or melting snow; b. Longitudinal flow on road surface; c. Splashing of mud.

The first is no doubt equal to the second and in our endeavor to control the first the second must be employed to a limited degree. The flow of water longitudinally on the road surface can be opposed by maintaining the proper cross-section, thereby overcoming the collection of water and its force.

Action of Calcium Chloride.—In order to overcome the action of traffic as far as possible some agent must be employed to reinforce the natural bond or to supplant it with an artificial one. Calcium chloride is a reinforcement and has the advantage of not destroying the natural bond when its effectiveness is apparently worn out. The tendency of the chloride is to penetrate the surface of the gravel and to crystallize; this strengthens the crust and the dustless feature can be quickly revived by another application. The simplicity with which calcium chloride can be applied is a decided advantage. The effectiveness of the chloride is enhanced by the use of a percentage of clay or limestone in the resurfacing material which should be uniformly mixed to obtain the best results.

In making a gravel patch if a small percentage of chloride is mixed with the gravel, the patch will stay put where otherwise dry material would be forced out by traffic and the hole still remain. Another method of patching is to first put the chloride into solution and then spray over the patch after it is made, being careful not to add so much of the solution as to produce a mortar.

All road men know the advantages of a rain in aiding the action of maintenance machinery, likewise the same benefits hold true where chloride is used. Naturally the moisture is greatest in the early morning and the early morning floating should not be disregarded on this account, as the machine's effectiveness is greatly increased and is therefore more permanent.

Because of the dust or binder being held on the road, repeated resurfacing is greatly reduced. The road must be watched, however, as the floating mat will become compacted in places and a crust will be formed, in which case fine gravel must be provided in a light layer as soon as possible. A conservative estimate would be that from 40 to 50 per cent less resurfacing is required where chloride is used.

Use in Winter Maintenance.—Some uses of chloride in winter maintenance might be mentioned. Although it may not be economical to remove a thick layer of ice for any distance, short patches can be removed where danger exists in a very short time. Also its use in removing ice from catch basins and culverts is very convenient. Where a winter haul of gravel is being made a strong solution of chloride for painting the gravel boxes prevents the gravel from freezing and sticking.

Hauling Road Material

Costs in Middlesex County, Ontario, Given in Paper Presented Road Construction Conference, Toronto

By CHARLES TALBOT
County Engineer and Road Superintendent, Middlesex County, Ontario

At the present time about 80 per cent of material used for maintenance is loaded by the teamsters who do the hauling, with some assistance in short hauls. For hauls over 2½ miles a teamster does not require assistance to load, provided the pit is kept in proper shape. He should not be expected to care for the pit or in way grade the gravel except perhaps to use a coarse screen over his box to remove the larger stone. On the shorter hauls a helper would be an advantage but unless the material has to be graded, screened or otherwise treated, the advantage is not sufficient to justify the investment. In deposits where the material has to be screened or crushed it should be elevated into bins so constructed as to control the material as it passes from the bins to the wagons. Stone or gravel shipped on railways should be removed from cars to wagons and trucks by mechanical devices.

Team Haulage.—It is by this method that the greater part of the material used for county and township road maintenance and township road construction is delivered.

A regular teamster working under favorable conditions will haul two yards of material (gravel or stone) and can drive his team about 24 miles per day. This is a good average and all that should be required. A charge of $6 per day is the usual price for such service. Gravel thus delivered will cost 25 ct. per yard-mile. The greater part of road material is delivered by farmers and they usually haul one-third of a cord to the load and drive 24 miles per day. At the usual wage of $5 per day, the gravel will cost 26.38 ct. per yard-mile. On hauls of less than two miles a team might average 20 miles per day, in which case the cost per yard-mile will be increased to 30 ct. and 31.66 ct., respectively.

Winter Haulage.—A great deal of stone and gravel is delivered to the roads during the winter. When hauled on sleighs it must be placed in storage piles and delivered in the spring as required. If hauled with wagons it can be placed on the road and if carefully placed and properly spread it will give better results than gravel put on the road in June. This work offers employment for the farmer at a season when neither men nor teams are busy at other work and their services can be obtained at a much lower wage than at other times of the year. Sleighing must be good or they cannot accomplish much but when it is good they will haul from 54 to 64 cu. ft. of gravel per load. On wheels, with a good road, they will haul 54 ft. In this way gravel can be delivered for 20 ct. per yard-mile.

If a municipality decides to improve roads with gravel at distances from 5 to 13 miles from the deposits, the work can be done at a very reasonable cost during the winter months, thus giving profitable employment to the farmer with equipment which would otherwise be idle.

There are many difficulties in connection with winter hauling of material such as the operation of the pit, the loading of the gravel when a number of teamsters desire to load at once, the piling of the gravel near the road to be improved when it cannot be placed on the road, and the placing of the piled gravel the following season. The mismanagement of any one of these items will make the work unsatisfactory as well as unprofitable.

Truck Hauling Costs.—Truck hauling costs depend largely on efficient drivers, and road and pit conditions. Four years ago the county of Middlesex operated trucks on bad roads and from a deposit difficult to work. We had two good drivers and two inexperienced ones. The work cost 28½ ct. per yard-mile for the season. The next year with experienced men on bad roads, and a reasonably good pit the cost was 22 ct. per yard-mile. During the last two years, we have operated from a good pit over good roads, and with good men and the cost was about the same both seasons. I am submitting in Table I a report showing the cost of the operation of the four trucks for the season of 1926. The cost per yard-mile including loading was 12¼ ct.

The four trucks and loader owned by the county of Middlesex cost $30,000. The depreciation on the machines was written off at the rate of 20 per cent of their value per year. The most expensive work during the year in which the depreciation was included in the cost was 28½ ct. per yard-mile. Two of the trucks have operated seven years and two trucks and the loader have worked six years. All are in serviceable condition.

Table I—Summary—4 Trucks

Truck No.	Miles travelled	Number of trips	Cu. ft. of material hauled	Gal. of gasoline	Qt. of oil
1	14,205	855	76,950	2,698	247
2	14,563	907	81,630	2,865	216
3	14,888	935	84,150	3,399	154
4	14,992	988	88,920	2,526	368
Totals	58,648	3,685	331,650	11,488	985

Statement Re Trucks, 1926

Wages of drivers	$ 4 245.69
Gasoline	3,386.66
New parts and shop repairs	1,838.43
New tires	928.58
Camp supplies	636.06
Oil and grease	484.24
Licenses for trucks	439.00
	$11,958.66

Possibly the most difficult part of the care of the country gravel and stone roads is the placing of the material in such quantities as is most advantageous and at the time it is most required. The objective of a road foreman should be to give the best service possible to the patrons of the road; and to place material so that it will cause the least inconvenience to the traveller.

In the last five or six years there has been a marked improvement in methods followed, in this regard, but much can yet be accomplished.

Laborer in pit at 35 ct. per hour; 1st truck driver at 40 ct. per hour and board; 2nd, 3rd and 4th truck drivers; cook, $48 per month and board; gasoline loader operated by truck drivers.

Average length of haul from pit to dump, 7.96 miles; average price per cord for 7.96 mile haul, $4.62; price per cord mile, 57.9 ct.; price per yard-mile, 12.25 ct.; trucks averaged 98 miles per day.

Profitless Bids

Attitude in North Carolina on Low Offers Outlined in Address Jan. 25 at 8th Annual Meeting of Associated General Contractors

By LESLIE R. AMES
State Highway Engineer of North Carolina

Breathes there a man who would dare to stand up before this convention and answer this question by saying "Yes." On the other hand you contractors gathered here know that there is not a state highway official in the county who desires any contractor to bid without a profit. The same question might be put to us as an individual by our merchant, our baker, our candlestick maker, and the reply would unanimously be the same—"No."

The laws which govern the world's progress are fundamental and true, because they govern today as they have always governed from the beginning of time. The laws of which I speak are not man-made laws, and for this reason they will never be altered or changed and they will last until time is no more.

The first law of this world of ours was that of "creation," and the second law that of "supply and demand." Each and every state road building organization must of necessity rely on these two basic and fundamental laws and nothing can be done to change or alter them.

Obligations of State Highway Commission.—The obligations of the state highway commission may be briefly outlined as follows:

1. The adoption of a definitely laid out system of state highways.

2. Location of roads which are most necessary to the public weal.

3. Engineering study of each location taking into consideration the various factors entering into alternate locations.

4. An intensive study and survey of the availability and quantity of local materials.

5. Decision and estimate of the present traffic, intensity, kind and weight, and also as to the expectancy of future traffic ten to twenty years hence.

6. Drawing of proper specifications and plans, one agreeing and tying in closely with the other so that the final product, the completed road, will in itself, or by progressive steps, be adaptable to the traffic requirements.

7. Proper methods of advertising and presenting these plans and specifications to the contracting fraternity in such a way that the state highway commission will receive bids, properly secured by a reputable bonding company to protect the taxpayer.

8. The proper award and execution of the contract.

9. Finally, the proper administrative and engineering organization to carry out the various details in connection with the steps outlined above.

The state of North Carolina has been singularly fortunate in having as chairman of the State Highway Commission, Frank Page, a man who has saved the taxpayers thousands of dollars, and a man who will always open his door to you contractors and will send you out feeling that you have gotten absolute justice.

The state cannot force a contractor to bid on its work nor can the state force a contractor to bid without a profit. The advertisements and proposals are sent out to contractors informing them that there is to be a public letting on a certain date under well defined plans and specifications, and it then rests with the contractors, as to whether or not they wish to bid and also as to the amount of their unit bids.

We have awarded contracts in this state in the amount of approximately $125,000,000, and there have been 41 actual defaults. This does not mean that 41 contractors have been defaulted, however. Considering the large program that has been carried on in the comparatively short period of six years, we feel that the percentage of defaults has been small.

Reasons for Defaults.—We have gone further than this and have analyzed the reasons for these defaults. Only two of the contractors defaulted due to underbidding their job. The other failures were due primarily to lack of experience in the contracting business. They had practically no equipment, which means that they had no funds. Six of the failures were directly traceable to neglect of business. Back of all this stands the bonding company, for the reason that if they had conducted the proper investigation before writing the bid bond, the majority of these defaults would not have occurred.

In this particular state, we do our utmost to so word the specifications that the minds of the commission and the contractor may meet in mutual understanding. Unless the specifications are explicit and in detail, there will be various interpretations placed on them by the contracting parties. It is also our desire in this state to make the contractor feel that it is his right and privilege to appeal from the decision of any subordinate, provided he thinks he is being required to do work outside the specifications.

After issuing the invitation for bids, the specifications, the plans, and the form of contract, it is up to the contractor to consider whether he will bid under said conditions. Should the state go further?

I assume—and it is on my part only an assumption, that the subject of this paper which was given me by one of your representatives, might be answered by saying—"Yes, the state should go further."

Determining Qualifications of Bidders.—The bids have been received and checked, and after tabulation we find a certain contractor has submitted the lowest bid. The question then arises as to whether or not the low bidder is responsible.

The North Carolina State Highway Commission before awarding a contract requires the low bidder to fill out a standard experience questionnaire and financial statement, which questionnaire and statement is carefully investigated before the actual award is made.

In awarding the contract, we do not hesitate to throw out the lowest bidder, provided in our opinion he is not responsible and is incapable of carrying out his contract. The contractor in signing the contract has bound himself to complete the work according to the plans and specifications. If he has bid without a profit there are always complications encountered by the contractor continually harassing the state highway official with the idea of producing inferior work which does not meet with the specifications.

Five Parties Involved in Contract.—While there are only three parties actually signing the contract, there are in reality five parties involved, namely: the state highway commission; the contractor; the bonding company; the material man; and the taxpayer.

If the contractor has bid without a profit, and particularly if the contractor is an irresponsible one, the five parties involved in the contract are soon surrounded by difficulties, due to the fact that the contractor is unable from his profits to pay the material man, and he is continually attempting to construct the work in such a way that he does not try to carry out the specifications.

One of the greatest difficulties with which the state highway officials have to contend is the fact that the contractor before signing the contract is not entirely familiar with the specifications. I believe that a great deal of missionary work could be done by your association by drilling into its membership the fact that before bidding on work of any nature, it is absolutely necessary to study and to know the specifications in detail under which the work is to be carried out.

The state highway commission of our state revises its specifications yearly. Considerable time and expense could be saved, both the contractor and the state highway commission, if the contractor would familiarize himself with the various details of the specifications.

It is my understanding that one of the chief objects and aims of the Associated General Contractors of America is directed to the end that responsible contractors may be insured. It is needless to say that the North Carolina State Highway Commission has no definite solution of this problem. However, we stand ready at any time to confer with your association, and are also willing at all times to receive suggestions from you.

Your association can also be the means of eliminating the dishonest contractor. Investigations by your association along with cooperation from the State License Board is the most practical solution of this problem.

The various joint conferences and discussions in meetings similar to this should be helpful to contractors in obtaining worthwhile information regarding construction methods in all the various phases of the big building industry now being carried on. A conscientious study and analysis of the information given out, a willingness on the part of the contractor to cooperate with the engineer, a concerted effort by contractors to be honest in their operations to put forth 100 per cent effort and industry after the work has been started, will be helpful in assisting a contractor to build the ultimate roadway and at the same time make a satisfactory profit commensurate with the finished product.

Pennsylvania Contractors Elect Officers

Edward McCrady, of Pittsburgh, was elected president of the Associated Pennsylvania Constructors, the state branch of the Associated General Contractors of America, at the seventh annual convention, held last month. Other officers elected are: Henry E. Baton, Philadelphia, first vice-president, and David A. Challis, Sewickley, treasurer, Charles H. Fry, of Erie, and Edward P. Arbogast, of Stroudsburg, were elected members of the Board of Governors for two years. Four regional vice-presidents were also elected by the meeting. They are: Foster H. Berkobile, Johnstown; David Schoentag, Saugertios, N. Y.; R. Chalmers Jacob, Philadelphia, and G. Vogelsberger, Scranton.

Should Engineer's Estimates Be Made Public?

An Interesting Discussion in Paper Presented Jan. 13 at Convention of American Road Builders Association

By ARTHUR W. BRANDT
Commissioner of Highways, State of New York

The title of this paper asks a question which the conclusion is supposed to answer. But the advantages and disadvantages of the publication of engineer's estimates are so nearly balanced that the writer finds it difficult to draw a conclusion which arguments justify and which can be successfully defended. In New York State, where the question has been argued for years, there are champions on either side and any discussion must, of course, be predicated on experience in that State, where engineer's estimates are published in accordance with the law.

The first appropriation for highway construction in New York State, made over 28 years ago, carried with it the provision that the engineer's estimate, plus a percentage for engineering and contingencies, should be appropriated for each contract; that with the advertisement of the contract the engineer's estimate should be published; that any bid exceeding that estimate was informal and must be rejected, and, last but not least, that the original appropriation set up for the construction of the road must remain so obligated until the completion and acceptance of the contract.

Engineer's Estimates.—Engineer's estimates are based, of course, on contractors' bids. It was only natural that the engineers should wish to keep their estimates as near the contemplated bid as possible, in order that a minimum amount of money should be tied up until the completion of the contract. Such estimates up to four or five years ago averaged about 10 per cent over contractors' bids. This caused a group of "shoe-string" or "fly by night" contractors to spring up—men who had little or no experience or cost data on which to base their proposals and generally but little capital with which to finance their contracts, and who bid on the engineer's estimate rather than a knowledge of the cost of work. Their method in securing a contract was simply to cut the estimate 2 or 3 per cent more than the average cuts of experienced contractors. Indeed, it was not uncommon in years gone by to hear an inexperienced bidder boast of securing a certain contract by guessing how much an experienced man, whom he knew wanted the contract badly, would cut the estimate and then cutting it 1 or 2 per cent more. It was common practice in those days to ascertain the prospective bidders on a contract and then "beat them to it."

Requires More Time.—To the layman, this might seem to be beneficial to the state, in that the work was done at a lower cost, but more often than not this happy result did not materialize. In the first place, such a contractor usually required much more time, due to lack of experience, equipment, capital, or, possibly, all three, and the extra engineering charges more than made up the difference between his bid and that of an abler firm. But, more important still, the public was deprived for a greater period of time of the use of the highway, and, after all, time is the essence of almost any contract and particularly of road construction.

The obvious solution of such a situation would be to reject the proposal on the ground that the contractor was not responsible and award the work to the lowest bidder, who, in the opinion of the awarding officer, was responsible. But, unfortunately, in New York State it has been ruled that any contractor who can furnish a bond is, in the eyes of the law, a responsible bidder.

New York Law Amended.—But New York State has largely done away with this type of contractor. In 1924, the Highway Law was amended to allow the appropriation set up for a road to be reduced, after the contract was awarded, to the actual bid price plus 10 per cent for engineering and contingencies. Although estimates will still be published, they need be and are of little or no value to the contractor, as they are made from 15 to 30 per cent higher than the actual value of the work, and for the last two years have averaged about 23 per cent above low bids. In other words, we are complying with the law in publishing the estimates, but we are getting results that might be expected if no estimate were published.

This change has been beneficial in more ways than one. In the first place, it is dangerous to bid on the estimates now, as such a bid may be so low as to be ridiculous and indicates a losing contract. As a result, the ranks of "mushroom" contractors have thinned amazingly in New York, at least as far as state highways are concerned. During the last three seasons, more than 400 contracts have been awarded to low bidders only and not one of them has defaulted. Before 1924, several defaults a year were common. In the second place, the high estimates have attracted desirable bidders from other states. It is a peculiar attribute of a highway contractor that he is loath to bid on an estimate only 5 per cent above his opinion of the value of the work, but he is keen to bid on one 25 per cent above that opinion. For instance, from 1921 to 1923, inclusive, several contracts were advertised and no bids received. The estimates were immediately raised and the contracts re-advertised. Not only were many bids received, but they were nearly all less than the original estimates on which these same contractors declined to submit a proposal. At any rate, New York is now enjoying the competition with our native contractors of many high class firms from as far west as Minnesota. We are convinced that increased estimates are responsible for this competition.

Disadvantages of Non-Publication.—Now, for a brief discussion of the disadvantages of the non-publication of engineer's estimates, the advantages of which have been taken care of above.

To the writer, only one disadvantage looms up that can be called important—the greater danger of unbalanced bids than would be present were estimates published and limitations placed on the amount that can be bid on any item, such as is used in New York. There is considerable opportunity for a contractor to unbalance his bid when estimates are published, but when they are not published all restraint is removed.

The bulk of the money in any highway contract falls into two items. First, excavation, which may be unclassified or divided into rock and earth, and, second, pavement, which may, in the case of concrete be carried entirely in one item, or, in the case of macadam, be divided into several. Some years ago, proposals were asked on a certain grading and paving job in New York. The estimate indicated that the excavation would run about 20,000 yd. per mile, which was in error, as it ran only about 10,000 yd. One contractor discovered this error before the bids were received and bid 1 ct. per yd. on excavation, increasing at the same time his bid on pavement items by approximately the amount saved. He was low bidder and was awarded the contract. While he suffered a large loss on excavation, he much more than made it up in pavement items. Shortly thereafter a rule was adopted that a bid on any item more than 10 per cent in excess of the estimate rendered the entire proposal informal.

Earth Excavation.—Only two years ago a contract which included several thousand yards of rock excavation was advertised. This rock was of a shaly character and the estimate was $2.50 per cubic yard. One contractor discovered that all of it could probably be removed with pick and shovel and most of it with a power shovel without blasting, which thereby placed it in the category of earth excavation. He bid 1 ct. on rock and spread the amount saved over the other items of the contract. The contract was awarded to and completed by him.

If these unbalanced bids had been properly noted and the estimate of quantities checked and corrected and the contracts re-advertised, the state would have saved many thousands of dollars. Furthermore, in both instances cited, if the final estimate quantities had been used in the original estimate, the bids of several other contractors would have

been lower than the bids of those to whom the work was awarded.

Some contractors, prone to unbalance their bids and take advantage of errors in the estimate of quantities, contend that they should be allowed to reap the fruits of their acumen. While no one can censure them for wanting to gamble on a sure thing, yet no highway official has the authority, legal or moral, to gamble with the state's money and all such bids should be rejected, if, after examination, the estimates are found in error. Other contractors, moreover, should have the assurance that the quantities, as advertised, are as nearly correct as they can be estimated.

Selection of Contractors.—A much more important thing than the publication or non-publication of engineering estimates, in the opinion of the writer, is the proper selection of contractors. Our law should be so drawn that awarding officials can require more than a bond as a proper qualification for the award of a highway contract which may run into many hundreds of thousands of dollars. Officials should have the authority to investigate the contractor from the standpoint of experience, equipment and organization and all bidders should be able to submit with their proposals a complete financial statement showing their net worth in liquid assets. The official should then have the authority to absolutely reject the proposals of all contractors who are not able to meet a certain minimum qualification set up as necessary for not only the proper completion of the contract but for its proper prosecution, in order that it may be finished in the shortest time consistent with good work. He should, moreover, have the authority to award to the lowest bidder who can meet the necessary qualifications and not be obligated to re-advertise because the low bidder is not responsible.

When such a system is devised, the status of highway contracting will be very much raised and will be not only more beneficial to the general public, for whom the work is being done, but will rebound to the benefit of those contractors who are well equipped and well qualified for highway construction but are unable to obtain work because of the cut-throat competition of men not properly equipped to do the work.

Marks Pavements Effectively

The streets and boulevards in Chicago and in other cities are now being marked by means of an interesting little appliance that has recently been placed on the market. This marker, designed to be driven into the pavement, is a mushroom shaped device that sets almost flush with the surface, and shows as a bright metal disc, arranged in lines or letters, to guide the motorist.

The marker has a monel metal top and body of malleable iron. The top of the device clears the pavement just enough to be clear of mud, rain, or slush, without interfering with traffic. Three sizes are available, one for small lettering and narrow lines, one for general use, and one for brick or asphalt streets. All are sold under a rigid guarantee, and while they cost a little more than a painted line, actually cost less than painting, since their permanence does away with the costs of repainting. They have proved more highly visible than the painted line, and thus aid in traffic control work.

The installation method used depends upon the paving, but in any case the expanding point acts as an expansion bolt and holds the marker securely in place.

The markers are manufactured by the National Traffic Appliance Corporation, Dept. A, 510 North Dearborn St., Chicago.

N. T. A. Safety Zone Markers Installed in Creosoted Wood Blocks, City Hall Square, Chicago

N. T. A. Marker Showing Dome Shaped Head of Bright Monel Metal With Prongs That Spread When Driven Insuring Permanent Anchorage

Distribution of Federal Aid Funds

The following tabulation shows the apportionment of Federal-aid funds for the fiscal year ending June 30, 1928:

Alabama	$ 1,547,220
Arizona	1,056,994
Arkansas	1,277,896
California	2,483,437
Colorado	1,376,520
Connecticut	472,685
Delaware	365,625
Florida	899,451
Georgia	1,979,209
Idaho	935,193
Illinois	3,154,429
Indiana	1,926,772
Iowa	2,044,999
Kansas	2,068,532
Kentucky	1,417,947
Louisiana	1,013,308
Maine	680,794
Maryland	635,119
Massachusetts	1,089,100
Michigan	2,214,691
Minnesota	2,120,741
Mississippi	1,307,879
Missouri	2,405,175
Montana	1,551,499
Nebraska	1,585,138
Nevada	948,510
New Hampshire	365,625
New Jersey	934,611
New Mexico	1,186,763
New York	3,635,217
North Carolina	1,713,356
North Dakota	1,194,951
Ohio	2,762,209
Oklahoma	1,751,891
Oregon	1,182,202
Pennsylvania	3,335,735
Rhode Island	365,625
South Carolina	1,054,988
South Dakota	1,220,064
Tennessee	1,614,766
Texas	4,497,272
Utah	846,906
Vermont	365,625
Virginia	1,442,714
Washington	1,131,532
West Virginia	793,636
Wisconsin	1,870,455
Wyoming	934,369
Hawaii	365,625
Total	$73,125,000

Primary Road Improvement in Iowa.—The Iowa Senate has adopted the highways committee bills to amend the state control bill and establish a definite plan for the improvement of the primary system. Approximately 4,900 miles of new paving are provided for as are also 6,600 miles of graveling. Amendments to the state road control bill extend the period in which the $5,000,000 of county bridge refunds are to be made from three to five years, provide for a state highway commission of five members and stipulate an auditor for commission accounts, such office to be filled by gubernatorial appointment.

Concrete Pavement Opened to Traffic in 4 Days

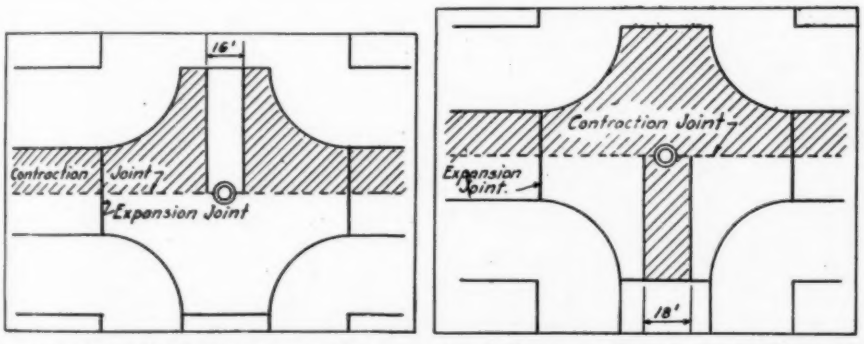
How Duluth Paved a Street That Could Not Be Long Closed to Traffic

Duluth solved a difficult problem during the past summer by using a little more cement, a little less water and a little longer mixing time for concrete pavement on a street which could not be long closed to traffic. These features, with carefully planned half-at-a-time construction, permitted "business as usual" in the city's wholesale district while the heavy traffic street was being repaved. How this work was handled is described by John Wilson, City Engineer, in a recent issue of Concrete Highways and Public Improvements.

After consultation with Prof. D. A. Abrams of the Portland Cement Association Research Laboratory, a mixture of 1 part of cement, 1½ parts of washed sand and 2¾ parts of crushed rock or pebbles was specified. Ordinarily the city uses 1:2:3 concrete, requiring 1.45 sacks of cement per square yard of 7½-in. pavement. The richer mixture required only 1.88 sacks per square yard of 8½-in. pavement, the thickness secured by solving the American Society of Municipal Improvements formula $t=\sqrt{\frac{3P}{f}}$ in which t=the thickness of the slab in inches, P=the maximum load in pounds and f=allowable fibre stress of concrete in tension. A 3-ton wheel load and a fibre stress of 250 lb. per square inch were assumed. Besides adding a little cement, the water-cement ratio was still further reduced by limiting the slump to 1½ in. instead of the 2 in. usually allowed, and the strength was further increased by requiring that the concrete be mixed 1½ minutes instead of the customary 1 minute.

With warm curing temperatures such a concrete should develop a compressive strength of 2,000 lb. in 8 days, which with the subgrade dry and firm should be strong enough to support ordinary truck loads. So the specifications allowed the street to be opened to traffic in 8 days when the minimum temperatures had exceeded 50 degrees Fahrenheit, or in 11 days when it fell between 40 and 50 degrees. An additional provision was made, however, that when standard 6 by 12-in. cylinders made from concrete taken from the mixer and cured on the job, developed a compressive strength in excess of 2,000 lb. per square inch the street could be opened.

It was this latter requirement which governed the time the concrete was cured. Three cylinders were made each day. At the end of 4 days two of them were tested. If they developed a strength of 2,000 lb. per square inch the pavement was opened; if not, the third cylinder was tested when 5 days old and if it developed the required strength traffic was allowed on the street. Usually the concrete developed a strength of 2,000 lb. in 4 days so that when the youngest concrete in a block was four days old, vehicles were allowed in that block.



A 16-Ft. Dirt Path Was Left in One Intersection and in the Next an 18-Ft. Concrete Path Was Laid

The average strength of 38 cylinders broken when 4 days old was 2,136 lb. per square inch; of 17 cylinders 5 days old 2,434 lb. and of 4 cylinders 6 days old 2,948 lb.

But even a 4-day period in which the wholesale houses could not haul to and from their storerooms would have meant the disappointment and possible loss of many customers who expected prompt shipment of orders. To avoid such a possibility the 33-ft. pavement was laid half-at-a-time and vehicles were allowed to use the unpaved half while the concrete was closed.

It was still more important that intersections be always open to traffic because over them the whole city must go to the docks and depots. This was accomplished by leaving a 16-ft. path unpaved across one intersection and paving an 18-ft. path clear across the next intersection, as shown in the accompanying sketch. While the concrete path in one intersection was hardening, vehicles used the dirt path in the next; then when the dirt path was being paved there was a concrete path across the intersections at each end of adjacent blocks.

The joint along the center line was both mortised and dowelled to make sure that the two slabs would act together. A groove was made in the edge of the first half laid by nailing a 2 by 4 to the forms. Dowels were ¾-in. deformed bars projecting 3 ft. into each slab and spaced at 2½-ft. intervals.

A ½-in. transverse expansion joint was installed on each side of intersections and between these, at intervals of 30½ ft., a transverse contraction joint was built. The latter was made by putting in a plate of 16 gauge metal, deformed to produce a mortised joint, and having a width ½-in. less than the depth of the pavement. The contraction joints were not dowelled, nor were they edged except in intersections, where a temporary metal cap was put on the metal strip, to be removed after the concrete was finished, so that the joint could be edged exactly over the division plate.

A total of 145 lb. of reinforcement was put in per hundred square feet of pavement. This consisted of ½-in. round, deformed bars running longitudinally, continuous between joints, spaced 12 in. center to center, and wire mesh weighing 78 lb. per hundred square feet. The bars were laid in place before any concrete was deposited. The ends were supported on 2 by 4's and workmen lifted the rest of the bar up to the center of the slab after a bottom layer of concrete had been laid. The mesh was spread over the bars, on top of the bottom layer of concrete. Both bars and mesh were put approximately in the center of the slab.

The completed pavement was kept damp for four days by covering it with strips of burlap which were sprinkled regularly.

Besides the 11 blocks on Michigan St. high early strength concrete was used to build 3 blocks of pavements 38 ft. wide on Fifth Ave., from the railroad yards to the docks. This street also carries heavily loaded vehicles. The same specifications were used and the same contractor, Salo and Wiinamaki, Duluth, had both jobs.

The average price of standard 1:2:3, 7½-in. concrete pavement reinforced with mesh weighing 40 lb. per 100 sq. ft. is, in Duluth, $2.40 a square yard. The contract price for the thicker, richer, more heavily reinforced pavement on Michigan St. was $2.63 a yard and on Fifth Ave. $2.69. Small as that additional expense was, only a very small part of the advance was due to the extra cement for high early strength.

Mileage of State System May Be Increased.—In a recent message, Gov. Bulow of South Dakota asked that 1,000 miles of highway be added to the state system.

Curb Form Supports for Concrete Bridges

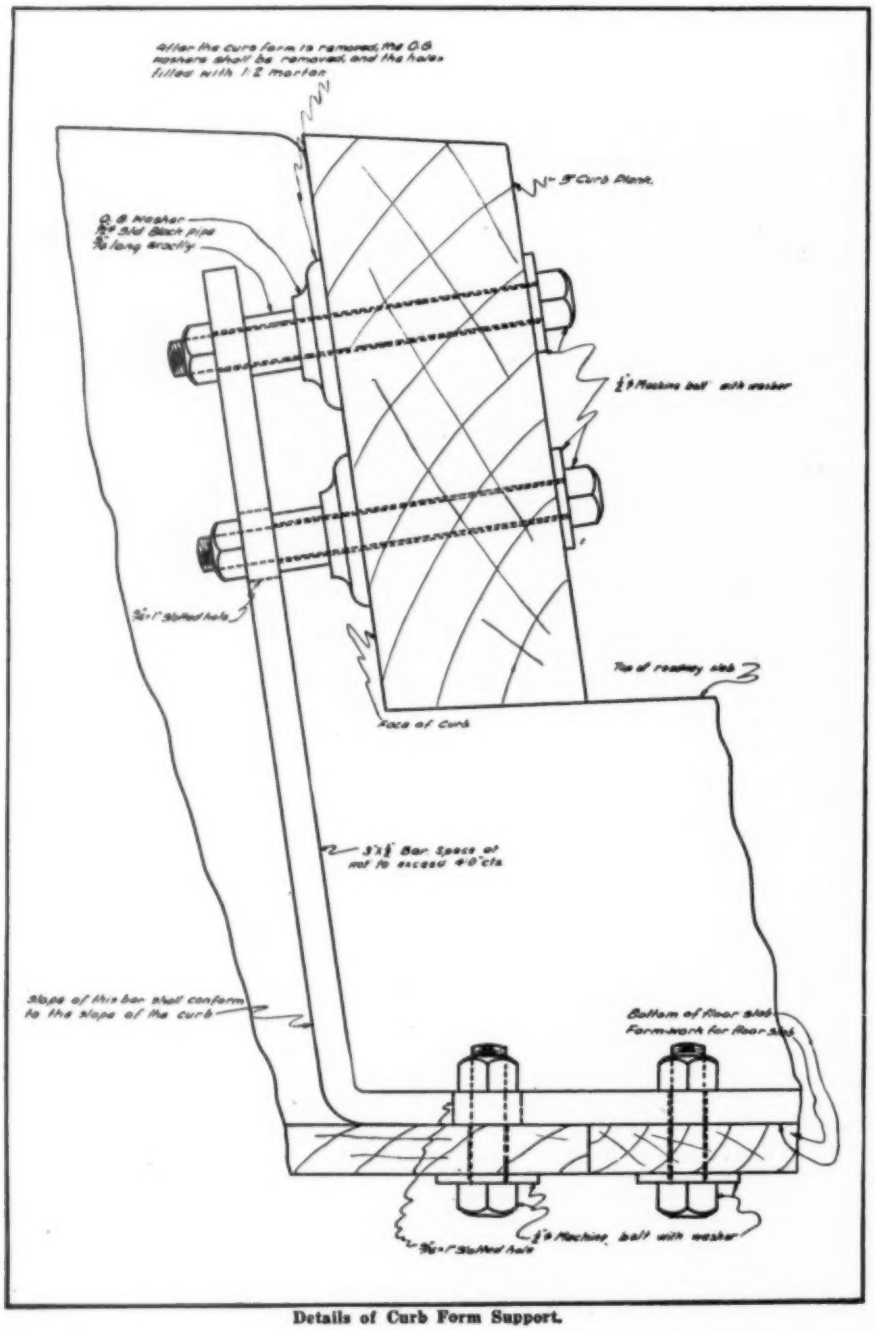
The present type of reinforced concrete bridge carrying a sidewalk presents a problem to the contractor as to how to hold the curb forms to line and grade when the nearest point to which wires may be attached is distant from 6 to 8 ft. It is not practical to wire the curb plank to the ribbon form to prevent spreading because of the stretch in the wires and the deflection under the weight of the concrete. If legs resting on the slab form and fastened to the outer face of the curb form are used to support the plank, they must be removed and the holes in the concrete filled before the concrete sets. The specifications call for striking off the floor, the strike board resting on the curb form. This necessitates a rigid support that will not deflect under weight or spring out of line due to the pressure of the concrete.

The following solution of the problem is offered in the December Badger Highways by F. M. Balsey, Construction Engineer, Wisconsin State Highway Commission. The supports are made out of 3-in. x ½-in. steel stock, bent as shown, with the face of the upper leg conforming to the batter in the curb. Holes to take ½-in. machine bolts are drilled in the horizontal and upright leg. One hole in each leg is slotted to facilitate lining up the brackets and adjusting the curb plank to the required grade.

In order to inset the brackets sufficiently so that the concrete will not crack on the face of the steel, a thimble ¾-in. long cut from ½-in. gas pipe, and a standard O. G. washer are interposed between the curb plank and the outer face of the bracket. When the curb form is to be removed the machine bolts are backed out releasing the plank. It will be noted that the bolts are so placed that the nuts remain in the concrete. The O. G. washers are removed by tapping lightly with a hammer, and the holes are then filled with 1:2 mortar.

In setting these brackets, set one at each end of the span, boring holes through the decking to coincide with the slotted holes in the foot of the bracket. Slip the bolts through the base of the bracket with the head of the bolt below the deck sheeting. Adjust these brackets to the required position and line up the intermediate brackets with a chalf line. In spacing the brackets be sure to avoid placing them in such a position as to block the floor drains.

Splices in the curb plank may be made by halving the plank and placing one bolt in each half or using a bracket each side of a butt joint.



Details of Curb Form Support.

New England Road Show

The third annual convention of the Massachusetts Highway Association will be held May 11 and 12 on the same site of the two previous shows, the Cottage Farm Bridge and Memorial Drive, Boston, Mass. The Secretary's report shows that in 1926 about 10,000 visitors attended the show, and as more elaborate arrangements are being made, not only in more equipment but also in publicity and special features, it is expected there will be an attendance of at least 20,000 this year.

President John A. Gaffey of the Massachusetts Highway Association is the director general of the show. John M. McCarthy is the secretary. The directors are: F. W. Mattheis, of the Hedge & Mattheis Co.; C. F. Reuter, of the Mead-Morrison Mfg. Co.; B. J. Surrett, of the Dyar Sales & Machinery Co.; James J. Tobin, of the Granite Paving Block Assn.; L. F. Bryant, of the Buffalo-Pitts Steam Roller Co.; Fred D. Richardson, Superintendent of Streets, Town of Brookline, Mass.; F. C. Pillsbury, State Engineering Department.

Mexico To Spend $5,000,000 on Roads.—According to an announcement of the National Highway Commission of Mexico, $5,000,000 will be spent this year for carrying out the road building program. The greatest attention will be centered on two principal highways, the first between the national capital and the city of Acapulco, principal port of the State of Guernero, on the west coast of the Republic, to which has been allotted the monthly sum of 500,000 pesos, and to the highway from Mexico City to the border city of Nuevo, Laredo.

500 Cu. Yd. County Gravel Plant

Installation of Macomb County Near Mount Clemens, Mich.

Macomb County, Michigan, which is now engaged in an exhaustive highway improvement program, installed recently a very complete gravel preparation plant. The installation consists of a cableway excavation unit and crushing, screening and washing units. The plant was installed on an 11-acre property near Mount Clemens, which contains a deep deposit of excellent gravel. The plant was placed in operation last July and added approximately 500 cu. yd. per day to the supplies of aggregate available for the county road commission's needs.

The mileage of concrete road completed last year was 45. Not content to rest on this record, the commission is planning to construct 77 miles of concrete pavements and 7 miles of new gravel roads in 1927. Included in this program are three concrete bridges. The estimated total cost is only a little over $2,000,000, a low figure for such a volume of work. The completion of the 1927 program will bring the total of improved roads in Macomb County up to almost 500 miles.

The excavating unit is a 1 cu. yd. Sauerman slackline cableway of the most improved type, including such refinements as a steel mast, roller-bearing sheave blocks and 2-speed electric motor hoist.

The Sauerman bucket operates over a 400-ft. span and digs to a depth of 60 ft., which is the full depth of the deposit. The bucket dumps the material on a stock-pile, beneath which runs a concrete tunnel. In the roof of this tunnel are six openings or chutes. The material feeds through these chutes onto a 24-in. National conveyor belt, 60 ft. long, which runs to a hopper over a crusher. This hopper is equipped with a Telsmith rotating grizzly which sends all material over 2 in. in size into the Telsmith crusher.

The finer material is by-passed around the crusher and together with the crushed material is carried by a second inclined National belt conveyor up to the Eagle scrubber-washer, an elongated inclined trough provided with an augur-like carrier which has a forward spiral propelling motion. The material to be washed falls into the lower end of this trough where it is thoroughly immersed in water and scrubbed. The refuse from this cleaning process is carried off at this same lower end by the overflowing water, while the clean product is propelled by the augur-like carrier to an opening at the upper end. Here it drops into a revolving cylindrical Telsmith washer screen, which separates the pebbles from the sand and gives both these gravel products a second and thorough scrubbing, the second scrubbing being an added safeguard against impurities.

The pebbles and sand find their way by separate motor-driven conveyors into separate 40 cu. yd. Butler loading bins. The aggregates are loaded from the bins into industrial trains that run over narrow gauge tracks to the concrete mixing plant out on the job. Twenty cars make up a train. Each car carries two batchboxes and each of these boxes is divided into three compartments—one for sand, one for pebbles and one for cement. A train of cars is loaded in 35 minutes. This haulage equipment is not new, having been used by the county in hauling material from other pits previous to the erection of the new plant.

Walter J. Lehner is county engineer, and W. T. McKenney is general superintendent of all the county gravel plants.

View of Macomb County Gravel Plant, Near Mount Clemens, Mich. Bucket Has Just Dumped Load of Wet Gravel Onto Stock Pile. At Extreme Right Can Be Seen End of Train of Aggregate Cars Pulling Out for the Job.

Asphalt Technologists Members of Highway Research Board

At a meeting last February of the Executive Committee of the Highway Research Board, the Association of Asphalt Paving Technologists was admitted to membership on the Board.

The objects of the Association are the advancement of the technology of asphalt pavement construction; and membership is limited to persons who are experienced in and whose duties are such as to make them interested in the technology of asphalt pavement construction, or persons who are interested and experienced in the technical problems of the production of materials used in the construction of such pavements.

Industrial Notes

The Directors of Fairbanks, Morse & Co., at the annual meeting March 29 elected W. S. Hovey president, the former president, C. H. Morse, becoming chairman of the board. This is the first time this position has been held by a man not of the original Morse family. Born in 1875, and a graduate of Cornell, Mr. Hovey joined the Sheffield Car Co., an affiliation of Fairbanks-Morse, in 1902, as assistant superintendent. Later he became superintendent, which position he held until 1913, when he was transferred to the Beloit Works of Fairbanks-Morse as manager of the engine division. A few months later saw him general manager of that plant. In 1919, Mr. Hovey was elected vice-president in charge of all the manufacturing activities of Fairbanks-Morse, and in 1924, was made general manager of the entire business. His elevation to the presidency brings a man to the helm of this company who has worked his way up through the ranks. His thorough grasp of all factors of this widely extended business makes him, in the opinion of his associates, well suited for the new office. He will remain general manager.

The Koehring Co., Milwaukee, Wis., manufacturer of pavers, mixers, gasoline shovels, cranes and draglines, announces the appointment of K. H. Talbot as director of sales, in charge of domestic and foreign sales. For five years, from 1919 to 1924, he was associated with the company as manager of field service. Mr. Talbot resigned as manager of cement sales of the Cowham Engineering Co. of Chicago to accept this appointment.

The Philadelphia Office of the Blaw-Knox Co. has been removed from the Colonial Trust Bldg. to 332 Widener Bldg. in Philadelphia.

The Harnischfeger Sales Corporation, distributors for Harnischfeger Corporation, announces appointment of George W. Gimlich as manager of the Harnischfeger Sales Corporation branch at Dallas, Tex. Daniel J. Murphy, former manager at Dallas, will open a new office at Baltimore, Md.

The Climax Engineering Co., Clinton, Ia., has completed arrangements with the Koehring Co. Associates, 50 Church St., New York City, to handle the sale of Climax engines, power units, and accessories for export exclusively in Argentina, Columbia, Italy, Panama, India, Philippine Islands, and the Japanese Empire.

O. J. Neslage of the St. Louis office sales staff, Sullivan Machinery Co., for several years past located in the Joplin, Mo., lead and zinc district, has been appointed local manager at Mexico City, Edificio Oliver No. 3. A. W. Oakes, for several years past manager at Mexico City, has been assigned to a post in the United States. C. W. Miller has been appointed special representative of the Sullivan Machinery Co. in Cuba and will cooperate with the company's general agents for Cuba. The Purdy & Henderson Trading Co., Habana 55, esquina a Empedrado, Havana, Cuba. Matt Brodie, manager for Asia, of the Sullivan Machinery Co., sailed recently from San Francisco for Tokyo, following a three months furlough in this country.

Monarch Tractors Corporation, Springfield, Ill., announces the appointment of the Weber Implement & Automobile Co. as distributors for Monarch tractors at St. Louis, Mo., for Southern Illinois and Eastern Missouri territory, and at Kansas City, Mo., for Western Missouri and Eastern and Southern Kansas; also the appointment of the E. F. Craven Co., Greensboro, N. C., as distributors for Monarch tractors in the state of North Carolina

The Oil Jack Company, Inc., manufacturers of the Pedersen Oiljak, has removed its general offices to 15 Park Row, New York City. This company is now in full production on two models of the Oiljak, the JB-3 up to 3 tons and the JB-10 up to 10 tons. These jacks are applicable for use with automobiles, busses and trucks, by builders and contractors, water-works, highway and fire departments, and for many other services.

The Fox Rotary Snow Broom Company, of which W. G. Fox is president, has announced the removal of the company's offices to Room 1809, 2 Lafayette St., New York City.

Arthur H. Nicholaus, advertising manager of the **Heil Co.,** Milwaukee, died on March 9, of pneumonia, at the age of 24, after a brief illness. Mr. Nicholaus, who joined the firm in 1922, attended Marquette University where he graduated as an honor student last June. While attending Marquette, he retained his connection with the Heil Co., of which he was appointed advertising manager upon his graduation.

Control of the Stockland Road Machinery Co. and the Lyle Culvert Co., both of Minneapolis, Minn., has been acquired by A. B. Wilder, pioneer road equipment manufacturer of that city, with the recent purchase of the interests of J. D. Fraser, formerly secretary and treasurer. Associated with Mr. Wilder in the active management of both companies is Cal Sivright, present vice-president and general manager of the Stockland Company, and vice-president of the Minnesota State Fair Association.

The Lyle Culvert Co. was organized by Mr. Wilder in 1905. The Stockland Road Machinery Co. was also organized in 1905 and was acquired by the Lyle Co. in 1920. The latter company does a large national and foreign business in road machinery. A large export business is done in Australia, South Africa, South America, Cuba, Norway and Canada. Two new units were recently added to the company's main plant at Minneapolis to take care of rapidly expanding business.

The Milwaukee offices of The Heil Co. announced the opening of a branch office, sales, and service station in Detroit. Roy L. Dierckmeier, formerly manager of The Heil Co. branch in Minneapolis and St. Paul, will supervise the organization of the new Detroit district. Mr. Dierckmeier has been intimately associated with the automotive industry for the last eight years and is well known among motor truck men. The Heil Co. will carry a stock of steel dump bodies, hydraulic hoists, hand hoists, and compartment truck tanks in Detroit as well as a stock of service parts so that a complete Heil service will be available.

The Full-Crawler Co., 500 Clinton St., Milwaukee, Wis., announces the change of its name to the Trackson Company, by which it will be known in the future. The change was made in order that the trade might more easily link the company name with that of its product, the Trackson Full-Crawler, for the Fordson Tractor. The Trackson Company remains a division of the George H. Smith Steel Casting Company, and retains the management, organization, and personnel of the former Full-Crawler Co.

The MultiFoote Sales Co. of 2811 West Fulton St., Chicago, general distributors in the middle western territory for the Foote Company, Inc., of Nunda, N. Y., announces a connection with J. J. Stockberger for handling the sale of MultiFoote Timken equipped pavers in the Indiana territory. Mr. Stockberger is located at 317 Dunnwood Drive, Fort Wayne, Ind. In the Chicago territory the sale of MultiFoote pavers is handled by the Lowe-Peters Equipment Co. at 612 N. Michigan Ave., Chicago.

H. J. Forsythe, president of Hyatt Roller Bearing Co., Newark, N. J., announces the appointments of H. O. K. Meister as general sales manager and A. W. Scarratt as chief engineer.

Pittsburgh offices of Hyatt Roller Bearing Co., recently named headquarters for the Central Sales Division, are now located at 806 Fulton Bldg., that city. They were formerly at 1352 Union Trust Bldg. The new location amply provided for the increased sales and engineering forces of the Central Division functioning under the direction of B. H. Lytle. H. R. London, a new member of the Pittsburgh force, is now operating in the industrial field of W. L. Iliff.

At the annual meeting of stockholders of the Belle City Manufacturing Company, Racine, Wis., held recently, the following directors were elected: Frank K. Bull, Stephen Bull, Harry A. Reed, William G. Thompson, Walter J. Tostevin, David G. Janes, Thomas B. Myers. Following the meeting of stockholders the directors elected the following officers: President and treasurer, Stephen Bull; vice-president and general sales manager, Harry A. Reed, secretary, Walter J. Tostevin, assistant secretary and assistant treasurer, George A. Nelson.

The United Rock Asphalt Co., Inter-Southern Bldg., Louisville, Ky., has been organized as a result of the consolidation of the Rock Asphalt Co. of America and other rock asphalt properties. William E. Massey, president of the Rock Asphalt Co. of America, is chairman of the board of directors of the new company. The officers of the United Rock Asphalt Co. are: President, Fred T. Fitzharris; secretary, Fred H. Mertens, and treasurer, J. D. Keller. A. C. Leathers is sales manager.

William Ford, president of the Universal Power Shovel Co. of Detroit, manufacturers of the Wilford power shovel and the Wilford clam shell, announces the appointment of C. E. Allison as sales manager. Mr. Allison has been closely identified with Fordson for many years, having done educational work for the Ford branch at Portland, Ore. Prior to that he was in charge of Fordson sales and service in Portland, working in conjunction with the seven metropolitan dealers. For the last five years, Mr. Allison has devoted his time to the perfection and sales of hoists built for the Fordsons. In his work among dealers and contractors he came to realize the great demand for a small, speedy power shovel and his present connection is the result. The past year has seen a number of improvements in the shovel, the adoption of special clutches, and a heavier crowd cable. In addition to these improvements the company has just announced a new clam shell, the boom of which is interchangeable with the shovel boom. It can be used for drag-line work as well.

New Trade Publications

The following trade publications of interest to highway officials, engineers and contractors have been issued recently. Copies of them can be obtained by addressing the firms mentioned:

Construction and Maintenance Equipment.—The Western Wheeled Scraper Company, Aurora, Ill., in celebrating the completion of their first fifty years of service to the earth moving industries, has issued an interesting booklet entitled "Fifty Years of Service." Herein may be found a short recital of the development of the company and of the equipment that they manufacture. The earliest scraper, grader and dump cars are illustrated. Mention is made of the earliest jobs on which Western equipment was used, and the booklet reviews the industries and the jobs that Western equipment has served. This Golden anniversary souvenir has been published in three editions, one general in scope, another covering dump cars, and the third featuring contractors' equipment.

Asphalt Booklets.—A booklet on each type of asphalt highway construction may now be obtained from The Texas Co., Asphalt Sales Department, 17 Battery Place, New York City. Useful information on each of the following types of road and street improvements is presented in these illustrated booklets: Sheet Asphalt, Asphaltic Concrete, Asphalt Macadam, Asphalt Filler for Brick Paving, Road Oil and Surfacing Material, Cold Patch, Resurfacing Worn Macadam and Gravel With Asphalt, Resurfacing Worn Brick and Block With Asphalt.

High Lift Unit for Dump Trucks.—The Wood Hydraulic Hoist and Body Co., of Detroit, Mich., announce in a folder a new mechanical high lift unit for dump trucks, that dumps material at a 62-degree angle on low lift, and at a 30-degree angle at 9 ft. from the ground.

Traffic Markers.—The International Nickel Company, 67 Wall St., New York City, in the current issue of their house organ "Inco," tell about many ways in which monel metal serves industry. One article of particular interest tells about how Chicago marks its streets with monel metal button-like markers. These markers are of the type manufactured by the National Traffic Appliance Corporation of that city. Because of the use of monel metal in these markers they not only have a long life and freedom from breakage, but remain bright and clean in spite of the weather. Other interesting industrial uses of monel metal are described in this interesting magazine.

Early High Strength Concrete.—The Lehigh Portland Cement Co. has issued a folder containing some convincing photographs and strength data on high early-strength concrete, obtainable "by anyone with the usual concrete materials." Data include test results on concrete work of two mixes; one with ordinary materials, and the other with the addition of calcium chloride. Graphs indicate a strength in 24-hour concrete of ordinary materials with careful proportioning of 2,270 lb. Photographs of the work are also shown. Copies may be obtained by addressing the Service Department of the Lehigh Portland Cement Company, Allentown, Penn., or Chicago, Ill.

Rock Asphalt.—The Kentucky Rock Asphalt Co., Inc., Marion E. Taylor Building, Louisville, Ky., has just issued an interesting booklet, "The Story of Kyrock." It not only tells about the advantages claimed for this paving material, but reviews the history of rock asphalt formation and use, and describes the process and the plant whereby Kyrock is produced. Many interesting pavements laid with this material are illustrated, and the use of Kyrock for resurfacing is featured. The same company has issued another booklet entitled "New Streets for Old," illustrating the use of the material for patching and resurfacing existing pavements of all types.

Pavers.—The Foote Company, Inc., of Nunda, N. Y., have just issued an interesting little booklet in celebration of the award to them of the gold medal of the American Institute. This booklet, entitled "A Tribute to the Roadbuilders of America," is circular in shape to represent the medal, and contains a brief history of the development of concrete highways, a history of the American Institute, and words of appreciation for the highway builder.

Paints.—The Headley Good Roads Company, Franklin Trust Building, Philadelphia, have announced a new line of asphalt paints. One is designed for structural iron and steel, one for the interior and exterior of water pipes, one for boilers and piping of a heating plant, one for patching a leaky roof, one for smokestacks, one for the protection of concrete, and one for the hulls and bilges of ships. These paints are said to be acid proof, heat proof, alkali proof, water proof, and rust proof. The water pipe paint is said to impart no taste or odor to the water and to last the life of the pipe.